THE EFFECTS OF A GROSS MOTOR INTERVENTION PROGRAMME ON PERCEPTUAL-MOTOR SKILLS AND ACADEMIC READINESS IN PRESCHOOL CHILDREN

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Thesis presented in fulfilment of the requirements for the degree

Master of Science in Sport Science

in the Department of Sport Science, Faculty of Education

at

Stellenbosch University

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March 2015

DECLARATION

By submitting this thesis electronically, I declare that the entirety of the work contained therein is my own original work, that I am the authorship owner thereof (unless to the extent explicitly otherwise stated) and that I have not previously submitted it in its entirety or in part for obtaining any qualification.

October 2014

Megan Kate Goodwin

ACKNOWLEDGEMENTS

I would like to thank the following people for their contribution to the completion of this thesis:

My family for their continued support and encouragement throughout the past two years, allowing me to be successful in my academic endeavours. Thank you for believing in me.

Dr E.K. Africa for directing me through the past two years, and helping me complete my thesis. You encouraged me to choose and follow my own path; while guiding and supporting my choices. Thank you.

Dr K.J. van Deventer for your support as a co-study leader. Thank you for your patience and the late nights spent working on my thesis.

Prof M. Kidd for the statistical analysis of all the data and careful explanation of the results.

The Western Cape Education Department for granting me access to the selected schools for the completion of my research.

The principals and Grade R teachers of the selected schools who gave up their class time for the testing and intervention sessions. Thank you for allowing me access to the learners and showing interest in this study.

To all the participants who eagerly took part in the testing and the intervention sessions. You brightened my days, and reminded me of what I love.

Shannon Hunter, Occupational therapist, for help with testing procedures and data collection.

Jarred Cooper, Kinderkineticist, for help with the gross motor testing of the participants.

Rachel Hitchcock for proof reading and editing my work.

Jeanne Cilliers for being my foothold in the real world. Thank you for supporting me and always being available for a chat and a laugh.

Nicola Fannin for being the best colleague one could ask for. Thank you for the constant entertainment throughout the past two years. We made it.

Yusuf Vahed for all your technological prowess. Thank you for helping out whenever needed.

SUMMARY

Children in preschool are at an optimal time for the development of gross and fine motor skills. Children who enter into preschool with developmental delays struggle to keep up with their peers. These developmental delays often perpetuate into later school years, with negative effects. Visual-motor integration (VMI) is a hugely important skill that children need to develop before formal schooling commences. It forms the basis for academic skills like reading and writing, as well as many sport skills. Having a VMI and/or gross motor development delay can affect a child's academic experience greatly. When referring specifically to reading and writing, many underlying gross motor processes occur simultaneously to enable the child to perform tasks successfully. Success in the classroom depends a great deal on developed VMI and gross motor skills.

Research shows investigation into various factors that account for differences and delays in motor skills. Socio-economic status is mentioned as a factor that can negatively affect VMI and gross motor skills development. Gender differences have also been known to be a reason for varying success in VMI or fine motor skills and gross motor skills. It is most important that delays and differences in VMI and gross motor skills success should be the focus of preschool education curriculums.

The purpose of the current study was to improve the VMI skills of children who presented below average VMI skills scores. The *Beery-Buktenica Developmental Test of Visual-Motor Integration 6th Edition* (DTVMI) was used to measure the participants VMI skills, and the *Test of Gross Motor Development 2nd Edition* (TGMD-2), was used as a measure of gross motor skills. The supplemental tests of the DTVMI, as well as the subtests of the TGMD-2, were performed. Two preschools were conveniently selected to participate in the study, one from a high socio-economic background and one from a low socio-economic background. Of the total participants initially tested (N=77), only a small number (N=23), scored below average VMI scores and continued to participate in the study. From these participants (N=23) an experimental (n=12) and a control group (n=11) were randomly selected. The experimental group participated in a 14-week intervention programme, two sessions per week each with a duration of 45 minutes, that focused on the underlying gross motor processes that relate to reading, writing and VMI skills. After the 14 weeks the participants were tested again to measure the effects of the intervention programme. All data collected were statistically analysed.

The most relevant result found in the current study showed that participants from the low socio-economic school showed significantly lower VMI skills than participants from the higher socio-economic school. No differences in VMI skills were found between the genders. Overall in both VMI and gross motor skills the intervention programme was beneficial to the participants, although these results were not found to be statistically significant.

This study emphasises that the disparities in VMI skills between children from low- and higher socio-economic backgrounds should be addressed before they enter school. This will ensure that these differences become minimised. This study suggests that gross motor activities can be beneficial to VMI skills of preschool children. More research is needed to fully determine the potential of gross motor intervention programmes in improving academic skills such as VMI.

Key words: Socio-economic status; VMI; Gross motor skills; Intervention programme

OPSOMMING

Voorskoolse kinders bevind hulle in ŉ optimale periode van groot- en fynmotoriese ontwikkeling. Kinders van hierdie ouderdom met ontwikkelingsagterstande sukkel om op skool by hulle eweknieë by te bly. Hierdie ontwikkelingsagterstande duur gewoonlik voort tot in latere skooljare met negatiewe implikasies. Visueel-motoriese integrasie (VMI) is ŉ baie belangrike vaardigheid wat kinders voor hulle formele skooljare in aanvang neem, moet ontwikkel. Dit vorm die basis vir akademiese vaardighede soos lees en skryf, asook vir baie sportvaardighede. ŉ Kind se akademiese ervaring kan baie nadelig deur ŉ VMI en/of groot motoriese ontwikkelingsagterstand beïnvloed word. Met spesifieke verwysing na lees en skryf, moet baie onderliggende groot motoriese prosesse gelyktydig plaasvind om die kind in staat te stel om take suksesvol uit te voer. Sukses in die klaskamer is grootliks van ŉ ontwikkelde VMI en groot motoriese vaardighede afhanklik.

Navorsing toon ondersoeke na verskeie faktore wat vir verskille en agterstande in motoriese vaardighede verantwoordelik is. Sosio-ekonomiese status word beskou as een van die faktore wat VMI en groot motoriese ontwikkeling negatief kan affekteer. Dit is ook bekend dat geslagsverskille ŉ rede vir variërende sukses in VMI- of fyn motoriese- en groot motoriese vaardighede is. Dit is van uiterste belang dat agterstande en verskille in VMI- en sukses met groot motoriese vaardighede die fokus van voorskoolse opvoedkundige kurrikulums moet wees.

Die doel van die huidige studie was om die VMI vaardighede van kinders met ondergemiddelde VMI vaardigheid tellings te verbeter. Die *Beery-Buktenica Development Test of Visual-Motor Integration 6th Edition (DTVMI)* is gebruik om die deelnemers se VMI vaardighede te bepaal en die *Test of Gross Motor Development 2nd Edition (TGMD-2)* is gebruik om hulle groot motoriese vaardighede te bepaal. Die aanvullende toets van die *DTVMI*, asook die sub-toets van die *TGMD-2*, is uitgevoer. Twee voorskoolse skole, een uit ŉ hoë sosio-ekonomiese- en een uit ŉ lae sosio-ekonomiese omgewing is met ŉ gerieflikheidsteekproef geselekteer om aan die studie deel te neem. Van die totale aantal deelnemers (N-77) wat aanvanklik getoets is, het slegs ŉ klein aantal (N=23) ondergemiddelde VMI tellings behaal om met die studie voort te gaan. Vanuit hierdie deelnemers (N=23) is ŉ eksperimentele- (n=12) en ŉ kontrole groep ewekansig geselekteer. Die eksperimentele groep het aan ŉ 14-week intervensieprogram, twee keer per week, wat elk 45 minute geduur het, deelgeneem. Die intervensieprogram het op die onderliggende groot motoriese prosesse wat net lees, skryf en VMI vaardighede verband hou, gefokus. Na afloop van die 14 weke is die deelnemers weer getoets om die effek van die intervensieprogram te bepaal. Al die ingesamelde data is statisties verwerk.

Die mees relevante resultaat wat in die huidige studie gevind is, dui daarop dat die deelnemers van die lae sosio-ekonomiese skool beduidende laer VMI vaardighede as die deelnemers van die hoër sosio-ekonomiese skool getoon het. Geen verskille in VMI vaardighede is tussen die geslagte gevind nie. Alhoewel die resultate nie statistiese betekenisvol was nie blyk dit dat in geheel beskou die intervensieprogram, in beide VMI- en groot motoriese vaardighede, voordele vir die deelnemers ingehou het.

Die huidige studie beklemtoon dat die verskille in VMI vaardighede tussen kinders vanuit lae- en hoë sosio-ekonomiese agtergronde aangespreek moet word voordat hulle in skole toegelaat word. Dit sal verseker dat hierdie verskille tot die minimum beperk word. Hierdie studie suggereer dat groot motoriese aktiwiteite voordele vir die VMI vaardighede van voorskoolse kinders kan inhou. Verdere navorsing is nodig om die potensiaal van groot motoriese intervensieprogramme op die verbetering van akademiese vaardighede soos VMI ten volle te verstaan.

Sleutelwoorde: Sosio-ekonomiese status; VMI; Groot motoriese vaardighede; Intervensieprogramme

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LIST OF ABBREVIATIONS

CD:	Compact disc
CEMIS:	Centralised Educational Information System
CSSA	Comprehensive Scales of Student Abilities
DTVMI:	Developmental Test of Visual-Motor Integration
DTVP-2	Developmental Test of Visual Perception
FMS:	Fundamental motor skills
FRTVMI	Full Range Test of Visual Motor Integration
GMQ:	Gross motor quotient
MABC-2	Movement Assessment Battery for Children
SAPIK:	South African Professional Institute for Kinderkinetics
SES:	Socio-economic status
TGMD-2:	Test of Gross Motor Development
VMI:	Visual-motor integration
WCED:	Western Cape Education Department
WRAVMA	Wide Range Assessment of Visual Motor Abilities

APPENDICES

CHAPTER ONE

PROBLEM STATEMENT

Introduction

Visual-motor integration (VMI) is an important perceptual-motor skill that a child needs to acquire in order to function successfully in an academic setting and beyond (Beery & Beery, 2004:129; Lotz *et al*., 2005:64). Academic skills such as reading and writing rely heavily on VMI, and academic success in schools today depends on whether a child can perform these skills optimally (Dankert *et al.*, 2003:543). Children entering into their formal academic careers need to have developed their VMI skills to a point where their reading and writing can be performed at the appropriate level so that no academic lags will take place.

The ability to coordinate visual perception skills and motor skills is referred to as visual-motor integration (Kulp & Sortor, 2003:312). Visual-motor integration has a perceptual or sensory component and a motor component (Sortor & Kulp, 2003:758). The visual-motor integration process effectively integrates the perceptual and the motor component. The sensory system perceives the environment on a visual level; after this the stimuli are transferred to the brain, and the brain attaches meaning to the visual stimuli received. The brain decides on an appropriate motor response to the visual stimuli and sends this response to the muscle groups (Goodale, 1998:491).

A child that has a VMI problem may have a problem with either visual perception, motor coordination of a motor response, or the combination of the two components (Sortor & Kulp 2003:758; Pieters *et al*., 2012:498). Visual-motor integration allows a person to copy a figure he/she sees onto a page, using his or her visual perception and motor skills together. A child with a VMI problem will have difficulty reproducing the figure he/she sees onto a page. Pieters *et al.* (2012:498) highlight the importance of focusing on the integration of both the visual and motor domains rather than focusing solely on visual perception or motor skills. Kulp and Sortor (2003:313) allege that a child may have completely normal visual perception and motor skills, but may have difficulty integrating the two abilities and, therefore, research needs to place emphasis on the integration process.

There is a lot of focus on the link between VMI and academic performance (Kulp, 1999:16; Dankert *et al.*, 2003:543; Sortor & Kulp, 2003:758; Lotz *et al.*, 2005:63). Beery and Beery (2004:121) believes that their test for visual-motor integration (VMI) is a predictor of future academic performance of children in kindergarten and the first grades of school. Marr and Cermak (2002:663) suggest that children must have visual-motor skills before formal handwriting can take place successfully. Visual-motor integration is seen as a very important part of a child's development and is an aspect that forms a basis for further development that needs to be nurtured before the first two years of formal schooling (Lotz *et al.*, 2005:63).

Academic skills include reading and writing of letters, symbols, numbers and words. Writing skills are imperative to academic success in formal schooling when one considers that 60% of academic activities during the day consist of writing (Van der Merwe *et al*., 2011:3). For success in the classroom, a child must be able to write legibly, as legibility is seen to influence grades (Marr & Cermak, 2002:661; Van der Merwe *et al*., 2011:3). When learning to read, children learn to differentiate first between letters, and then words, and in mathematics they need to learn to differentiate between numbers and arithmetic symbols (Kulp, 1999:160). Visual-motor integration skills mean combining these two academic components. To write, one must be able to see and recognize a word or symbol and be able to reproduce or copy it (Feder & Majnemer, 2007:313).

Much has been written about the underlying factors that influence a child's academic performance specifically in reading and writing. These factors relate to VMI. Cheatum and Hammond (2000:101, 110, 116, 150, 162, 263) refers to gross motor processes such as laterality, directionality, midline-crossing, as well as problems with the vestibular and visual system all of which could have an influence on whether a child can read and write. Other research lists postural control, upper body coordination and stability as other important factors that could influence writing and reading performance (Oliver, 1989:115; Marr & Cermak, 2002:663; Van der Merwe *et al.*, 2011:4; Van Jaarsveld *et al.*, 2011:6). Motor control and motor planning, as well as the coordination of muscles involved in bodily movement and eye movements are also said to be crucial to successful reading and writing (Dankert *et al.*, 2003:542; Van Jaarsveld *et al.*, 2011:6; Wajuihian & Naidoo, 2011:92). The proprioceptive system, along with the tactile, vestibular and visual systems all play a role in the reading and writing process (Dankert *et al.*, 2003:542; Feder & Majnemer, 2007:313; Van der Merwe *et al.*, 2011:4).

There is research in the field of occupational therapy on the effectiveness of an occupational therapy intervention on VMI skills and the improvement of academic performance (Van der Merwe *et al.*, 2011; Van Jaarsveld *et al.*, 2011). The current study focuses on the emerging field of Kinderkinetics. Research in the South African context has highlighted the need for early intervention and attention to pre-reading and -writing skills at preschool level (Van der Merwe *et al.*, 2011:3). Research has called for a way to introduce effective intervention programs into the school setting (Kulp, 1999:162).

The current study aims to determine whether a gross-motor intervention programme that focuses on VMI and other underlying processes involved in reading and writing can improve the participants' VMI and, subsequently, their academic readiness and performance. This study aims to develop a teacher-friendly intervention programme that can be used in the school-setting to improve children's VMI skills and academic readiness.

Problem statement

The primary aim of this study was to determine whether the VMI skills in preschool children can be improved through an intervention of gross motor activities.

Specific aims

1. To determine the VMI skill level of preschool children.
2. To determine whether there were differences in VMI skills between boys and girls at this age.
3. To determine whether a self-designed gross motor intervention programme improved the VMI skills.

Hypothesis

The hypothesis of the current study theorizes that the visual-motor integration skills of the experimental sample can be improved through the gross motor intervention programme.

Rationale

A study of visual-motor integration skills before school-going age is important because a child must have developed these skills before entering into school where formal teaching of reading and writing skills will occur. This study focused on children in preschool education programs, because it is the optimal age to begin monitoring the readiness for formal teaching of writing and reading skills.

Methodology

Study design

This study made use of a quasi-experimental design. Two preschools in the Stellenbosch region were approached by the researcher to participate in the study. Literature on the subject suggests that there are differences between the VMI skills of children from different socio-economic backgrounds and, therefore, one school was situated in a low socio-economic community, and the second school was situated in an area of higher socio-economic status.

Sample

The Grade R learners (N=77) in the selected preschools were asked to participate in the study. After the participants' VMI skills were determined, participants were excluded if their VMI skills were found to be average or above. The remaining participants (N=23) scored below average on VMI skills and were all in the lower socio-economic status (SES) school (no participants from the higher socio-economic (SES) school qualified to participate further). The participants were randomly divided into an experimental (n=12) and control (n=11) group and boys (n=17) and girls (n=6) were randomly distributed between the two groups.

Testing procedures

In this study, two motor tests were performed before and after the intervention program. The subjects performed the Beery-Buktenica Developmental Test of Visual-Motor Integration, 6th Edition (Beery & Beery, 2004), and the Test of Gross Motor Development, 2nd Edition (Ulrich, 2000). Detailed description of the tests and procedures are described in Chapter three.

Intervention programme

An intervention of 14 weeks followed the pre-test. The intervention sessions were performed twice a week for the allotted 14 weeks, each session lasted 45 minutes, with actual activity-time being 30 minutes. The sessions were implemented within a small group setting. The experimental group consisted of 12 participants across the two Grade R classes; this group of 12 was divided into two groups of six participants from each class, in order to minimize the influence that different teachers might have on the results.

A group setting was used to emphasise that this type of intervention can easily be used in schools on a regular basis with the whole class.

The gross motor intervention focused first and foremost on VMI which includes activities like target games, where various objects must be thrown, kicked or rolled to a specific target, either on the floor, in the air, or to a person who catches the object. Catching is also included as a VMI skill. Visual perception skills (perceiving picture differences) and motor coordination (threading beads onto a lace, connecting dots on pictures) was practised separately as well.

The following specified underlying factors relating to VMI and academic skills were also the focus of the gross motor intervention: laterality; directionality; upper body strength and coordination; motor planning and coordination; and proprioception. These will be discussed in Chapter two.

Statistical analysis

Baseline comparisons of schools and gender were done using 2-way factorial ANOVA. Comparisons of the experimental and control groups from pre- to post-testing were done using mixed model repeated measures ANOVA. Group and time were treated as fixed effects and the subjects as random effects. Post hoc testing was performed using Fisher least Significant Difference (LSD) testing. Summary statistics were reported as means with standard deviations. A 5% significance level ($p<0.05$) was used as the guideline for significance testing.

Ethical aspects

Ethical clearance for this study was obtained from the Research Ethical Committee of Stellenbosch University (HS1013/2013). Thereafter, permission for the study to commence in the schools was obtained from the Western Cape Education Department (WCED). Permission from the principal of the schools and the head teachers of the Grade R classes were obtained after permission had been received from the WCED.

Each participant's parent or legal guardian gave informed consent for their child to participate in the testing and intervention procedures. The procedures were explained to the children and each child was asked to sign an assent form; giving their consent and willingness to participate in the testing and the intervention procedures.

Outline of chapters

This chapter has briefly outlined research on the importance of visual-motor integration for young children in preschool years. This short discussion leads to the rationale for studying the current topic. Specific aims are delineated briefly; creating a hypothesis that ultimately asks "will this intervention programme work"?

The subsequent chapters of this thesis will give a detailed chronicle of the research performed. Chapter two illuminates previous research found on the topic of the current study.

Chapter three provides in more detail the specific methodology and procedures used with regard to data collection. Chapter four provides the statistical analysis of the data found, with discussion of previous research relating to the current study. Finally chapter five provides a neat conclusion of the results, along with recommendations for future studies and practice.

CHAPTER TWO

LITERATURE REVIEW

Introduction

Preschool children are at a critical age for childhood development (Hardy *et al*., 2010:503). Researchers define the preschool years as the most optimal time to intervene and remediate developmental lags since children are more pliant at this age and formal schooling has not yet begun (Ratzon *et al*., 2009:1169; Hardy *et al*., 2010:504). Visual-motor integration (VMI) is one of the skills that must be developed early in childhood before formal education commences (Marr & Cermak, 2002:663; Lotz *et al*., 2005:63). Academic skills like reading and writing have been strongly linked to VMI skills (Dankert *et al*., 2003:543; Kulp & Sortor, 2003:312; Beery & Beery, 2004:121; Cameron *et al.,* 2012:1239; Pienaar *et al*., 2013:375). Remediating children's VMI skills deficits in the preschool years will help to decrease the developmental and academic lags they encounter when compared with their peers (Marr & Cermak, 2002:662; Ratzon *et al*., 2009:1174; Pienaar *et al*. 2013:376).

On the premise of the importance of VMI skills the current study investigated the use of a gross motor intervention programme in remediating VMI skills of selected preschool children. The literature review will focus on the association between VMI skills and academic performance, reading and writing, gross motor skills, school readiness, socio-economic status and gender differences.

Visual-motor integration

Visual-motor integration can be defined as the ability to link visual perception with fine motor coordination (Lotz *et al*., 2005:63). Fine motor skills require the child to use and coordinate hand and finger movements (motor coordination skills), while he or she must rely on hand-eye coordination (visual perception skills), to successfully complete the task (Lotz *et al*., 2005:63). Feder and Majnemer (2007:314) defines VMI as the coordination of visual information and a motor response, which enables the child to copy letters and numbers on to paper in school tasks. Visual-motor coordination allows an individual to manually produce legible letters accurately and fluidly (Mäki *et al*., 2001:644). Dibek (2012:1925) defines VMI skills as the conversion of visual perception into a motor output.

Visual-motor integration has three components: visual perception, motor coordination and the integration of the two (Kulp & Sortor, 2003:313; Sortor & Kulp, 2003:758). Pieters *et al*.

(2012:498) explain that VMI skills used in copying a figure can be affected by the child's visual perception abilities (used in perceiving a figure), and/or the child's motor abilities (used in drawing a figure). Sortor and Kulp (2003:758) assert that a child's performance on a VMI test could be influenced by visual discrimination ability, motor skills or the integration of the two skills.

Visual-motor integration and the academic setting

Visual-motor integration is a skill that is very important in academic settings and beyond (Beery & Beery, 2004:129). The relationship between VMI and academic skills and success cannot be overestimated when considering that pen and paper activities are the primary focus of everyday school tasks (Dankert *et al*., 2003:543). Visual-motor integration skill scores have been linked to future academic success and have been named as a predictor of academic performance by many studies (Dankert *et al*., 2003:544; Kulp & Sortor, 2003:312; Sortor & Kulp, 2003:758; Dunn *et al*., 2006:951). Similarly Cameron *et al.* (2012:1239) identified fine motor skills, particularly the ability to copy designs, as a predictor of achievement and success in kindergarten. Beery and Beery (2004:121) note that their Developmental Test of Visual-Motor Integration (DTVMI), is a valuable predictor of academic success.

Children in preschool performing pre-academic skills like copying shapes and letters need VMI skills in order to be successful in these tasks (Dankert *et al*., 2003:543). Van der Merwe *et al*. (2011:3) found that occupational therapists in South Africa use the DTVMI as a measure of handwriting performance and mention VMI skills as a component of handwriting. Since VMI is related to successful handwriting, it is seen as having a link to academic success because the learning of legible handwriting is an important part of the academic day (Marr & Cermak, 2002:661). Failure in acquiring fast and legible handwriting skills is associated with poor school performance (Vinter & Chantrel, 2010:476).

Mäki *et al.* (2001:662) found that VMI skills in preschool predicted handwriting mechanics in Grade 1. Visual-motor skill delays can have an effect on children entering into school (Ratzon *et al*., 2009:1169). Considering how important VMI skills are for handwriting it is of great importance to detect and swiftly remediate deficits in VMI skills in the early school grades so that children can cope with school assignments and decrease any significant gaps between their peers which will help prevent negative experiences later on in school (Marr & Cermak, 2002:662; Ratzon *et al*., 2009:1174; Poon *et al*., 2010:1559).

Pieters *et al*. (2012:502) found a link between VMI skills and mathematical skills. Children with mathematical learning difficulties showed lower scores in visual-motor integration skills when compared with control participants with no mathematical learning disabilities. When a child attempts to calculate mathematic sums spatial organization and alignment of the numbers is important for successful calculations and these factors relate to VMI skills (Barnhardt *et al.,* 2005:141). Dunn *et al.* (2006:951) discuss how VMI skills influence a child's ability to master reading, writing and mathematics skills in the early school years. A positive relationship between VMI, readiness to learn, reading and maths has been found (Sortor & Kulp, 2003:758; Pienaar *et al.*, 2013:375). Sortor and Kulp (2003:760) found that there was a relationship between visual perception and visual motor abilities and maths and reading abilities, while Pienaar *et al*. (2013:375) found that mastery of maths, reading and writing were associated with VMI skills.

Writing and reading skills

Handwriting is a hugely important academic skill that children begin to learn in the early school years (Feder & Majnemer, 2007:312; Lust & Donica, 2011:560; Van der Merwe *et al.,* 2011:3; Duiser *et al*., 2013:76). Visual-motor integration has been noted by many researchers as an important component of handwriting (Daly *et al*., 2003:461; Feder & Majnemer, 2007:313; Lust & Donica, 2011:560; Duiser *et al*., 2013:76). Van der Merwe *et al*. (2011:4) highlight VMI as a sensorimotor component of handwriting; they note that it has been found to be a significant factor that influences handwriting quality. Mäki *et al.* (2001:663) name VMI as a writing-related readiness skill in preschool that predicts future writing success. Cheung (2007:108) also found that VMI skills were the main factors influencing children's handwriting ability.

The DTVMI measures perception of forms, fine motor skills, and motor planning and sequencing abilities, which are all skills that play a significant role in handwriting (Barnhardt *et al*., 2005:138). The DTVMI is used to determine handwriting performance and difficulties because the primary requirement of legible handwriting is the ability to recognise different shapes using vision and coordinate and control arm, hand and finger movements to reproduce the shapes (Duiser *et al.,* 2013:77). Because of the link between VMI skills and handwriting the DTVMI has become very popular amongst occupational therapists in South Africa as a measure of handwriting performance (Van der Merwe *et al*., 2011:8). Duiser *et al.* (2013:80) found a positive correlation between the VMI and motor coordination subtests of the DTVMI and the Concise Assessment Scale for Children's Handwriting test, if learners scored well on the VMI test they scored well on the handwriting test. Ratzon *et al.* (2009:1175) discuss how the testing of handwriting can only commence in the first grade of school, and therefore, testing VMI skills that are related to handwriting is sufficient for preschool children.

Bara and Gentaz (2011:746) describe handwriting acquisition as a slow and difficult process for young children, requiring several years of formal practice and training before total mastery of the skill occurs. Handwriting acquisition consists of learning the visual representation of letters as well as the motor representation of each letter; the visual representation guides the motor production of the letter (Bara & Gentaz, 2011:745). Vinter and Chantrel (2010:476) describe handwriting as a perceptual-motor skill where the perceptual component refers to the letter shape and the motor component refers to the movement the child makes in order to produce the letter.

Young children begin to write after they begin to draw. Children are generally very eager to begin to write, and preschool education institutions provide numerous writing and drawing materials to provide writing and drawing opportunities (Diamond *et al*., 2008:468). The development of handwriting begins with children scribbling randomly, which over time becomes more intentional (Feder & Majnemer, 2007:313). Children show their eagerness to write and their understanding of writing during their play time; children write out addresses while playing post office games, show friends how to write, write out a restaurant order or bill (Diamond *et al*., 2008:468). They begin to write letters by imitating first vertical strokes, then horizontal and then circular shapes. These letter shapes can be seen in children's early drawings and scribblings (Feder & Majnemer, 2007:313). When children start writing, their first focus is learning to copy and write their own name, and it is interesting to observe how often the letters in their names tend to come up in their other writing endeavours (for example, when pretending to write a list in dramatic play) (Diamond *et al*., 2008:468).

Formal handwriting instruction begins in Grade 1, but many preschool teachers and curriculums include pre-writing skills and simple tasks like letter reproductions and writing their names (Marr & Cermak, 2002:661). Mäki *et al.* (2001:644) discuss the need for early detection of handwriting and visual-motor deficits in order to provide remediation to at-risk scholars before the first grade. Multisensory pre-writing and handwriting readiness programmes are important in preschool curriculums to prepare children for the early school years (Lust & Donica, 2011:561).

A link between perceptual and motor skills within reading and writing is suggested. Letters are denoted in the brain by both visual and motor representations, therefore, exploration of letters in a motor, haptic (touch) and visual way will lead to more complete letter memorisation and recognition (Bara & Gentaz, 2011:756). Vinter and Chartrel (2010:477) discuss how visual perception of letters is based on motor knowledge of the letter. Bara and Gentaz (2011:752) found that children who participated in a perceptual and motor intervention improved the quality of their general handwriting more easily than those who participated in a one-dimensional (only visual perceptual) intervention. The children who were given opportunities to explore letters and letter shapes haptically (through touch and proprioception) were able to better perceive, identify and memorise letters. Having letter representations comprehensively ingrained in memory is essential in producing motor representations of the letters (Bara & Gentaz, 2011:752). Vinter and Chartrel (2010:484) found that intervention of visual-motor training that involved motor reproductions of a letter, as well as visual productions of the letter in motion, was most effective in teaching handwriting.

Diamond *et al*. (2008:468) describe how writing is critically important for children who are learning to read; writing and copying letters helps children pay attention to print and recognise differences between letters, which helps them to distinguish between letters when learning to read. Lust and Donica (2011:561) mention that handwriting difficulties could predict children's future reading challenges and achievements. Longcamp *et al.* (2005:68) discuss how movements organize perceptions and link this to learning to read. Alphabetic letters are reproduced by very specific hand movements, and when a children read a letter they accesses their perceptual-motor system and recognize the letter through the memory they have of writing the letter (Longcamp *et al.,* 2005:68).

Reading is described as possibly the most important educational skill for success in the educational setting and in life and is the key to opening all other domains of education (Hagan-Burke *et al*., 2006:1). Reading allows us to understand written texts and is a crucial skill needed in these days where the written word is pervasive (Gentaz *et al*., 2013:1). Reading is described by Soderman *et al.* (1999:10) as a dynamic process that requires proper timing of eye movements and fixations so that information can be acquired from the text. Children in a preschool classroom need to acquire ways of quickly understanding visual information; various scanning, focusing and visual coordination skills are used when obtaining meaning from printed text (Soderman *et al*., 1999:10). Lonigan *et al.* (2000:596) refer to reading as being critical in forming the foundation of future academic success; they note that poor reading skills hinder acquisition of knowledge in other academic areas.

Letter recognition is a component of learning to read (Hagan-Burke *et al.,* 2006:5). Lonigan *et al*. (2000:597) note that alphabet knowledge, knowing the names and sounds of letters, is a critical component of short- and long-term success in learning to read. Other components of learning to read include understanding print concepts such as: one reads from left to right; and from the top of the page to the bottom (Lonigan *et al.,* 2000:600). Laterality and directionality concepts (left and right knowledge and top-bottom references), find their foundations in gross motor body awareness (Cheatum & Hammond, 2000:100; Ofte & Hugdahl, 2002:707; Sherry & Draper, 2013:1303).

Motor development through infancy and early childhood

Infancy and childhood are important years for growth and change in motor skills (Gerber *et al.*, 2011:267). Malina (2004:50) defines motor development as the progression that a child follows when acquiring movement skills and patterns. This developmental process is orderly and follows a predictable pattern (with some slight inter-individual differences) (Gerber *et al*., 2011:267). Haywood and Getchell (2005:5) define motor development as a sequential, continuous and age-related process through which motor behaviour changes. Each child passes numerous developmental milestones during their infant and early childhood years: these milestones provide references by which observers can determine the child's overall developmental state (Gerber *et al*., 2011:267). Malina (2004:52) describes developmental milestones as the mastery and control of specific voluntary movements during infancy and childhood.

The development of a child is said to be influenced by specific growth and maturity characteristics of the children and their interaction with their environment (Malina, 2004:50). Gerber *et al*. (2011:267) discuss that the influence of genetic characteristics of the child, and the child's general state of wellness; influences from the family members and caregivers; socio-economic status of the family and the cultural background of the family all have an effect on the development of the child. Hardy *et al*. (2009:503) briefly list internal and external factors like biological, psychological, social, motivational and cognitive as effecting motor skills development, but they emphasise the effect of free-play and structured programmes on the optimal development of motor skills in children.

Very detailed accounts can be given for motor development in infants and children, with specific ages outlined as standard references of development (Folio & Fewell, 2000; Gerber *et al*., 2011:269-2272). A general overview of a child's motor development will be provided in the section below.

Gross motor development begins in the womb with foetuses displaying reflexive movements while in utero (Malina 2004:51; Gerber *et al*., 2011:268). These reflexive movements continue during the first three months of their lives and are named primitive reflexes (Malina 2004:51; Gerber *et al*., 2011:268). Primitive reflexes include the Moro reflex, asymmetric tonic neck reflex, grasping reflexes and positive support reflexes (Malina 2004:51; Gerber *et al*., 2011:268). Primitive reflexes propagate involuntary movements in the child which helps the development of muscle tone and strengthens motor pathways; this helps the child to develop the muscles and coordination used in later voluntary movements. The primary function of infants performing rhythmic movements like waving the arms and legs is to improve control of the specific motor patterns (Pellegrini & Smith, 1998:582). When an infant kicks his legs rhythmically, moving his ankles, feet and hips in coordination, this seemingly spontaneous movement mimics adult walking movements (Haywood & Getchell, 2005:69).

During the first few months of the child's life, the primitive reflexes dominate motor development. Primitive reflexes lose their intensity after the first three months after birth (Malina, 2004:51). The primitive reflexes remain until about six months and then gradually become integrated and inhibited and form part of voluntary movements (Malina 2004:51; Gerber *et al.,* 2011:268). Gerber *et al*. (2011:51) alleges that between the ages of six to nine months postural reflexes begin to emerge; these include righting and protection responses (righting oneself back to a state of equilibrium). These equilibrium responses allow the child to begin the journey towards walking. Between the ages of six and nine months the child begins to move into a seated position and from there the infant will begin to pull up from a seated position into a standing position (nine months) and then walking (12 months) (Gerber *et al.,* 2011:268). The equilibrium reactions and reflexes that are developed continue to develop over time and when the child reaches his or her second year of life he/she can maintain equilibrium during more intense locomotor movements such as running and jumping (Gerber *et al*., 2011:268).

Malina (2004:53) describes walking as the great developmental milestone that is reached within the first two years of life. He describes the journey as a gradual process beginning with the ability to sit upright, then maintaining upright posture without support, which leads to movements on the tummy such as crawling and creeping, standing with support to standing alone, which then develops from walking with support to walking alone (Malina, 2004:53). Walking in the early stages is stiff and unstable, with a wide base of support which allows the child to maintain balance more easily (Malina, 2004:53; Gerber *et al.,* 2011:268). Walking is seen as the first major motor skill to develop and once it is achieved successfully, other more complex fundamental motor skills can be developed. Walking is the foundation for future motor skills development (Malina, 2004:54; Gerber *et al*., 2011:268). Basic locomotor skills are mastered before more complex manipulation skills which require the coordination and stability of the trunk and limbs for mastery (Hardy *et al*., 2010:507). After the onset and mastery of locomotion, further development can begin within "exercise play", a type of play where children are vigorously active and have physical training and motor developmental benefits (Pellegrini & Smith, 1998:582).

Fundamental movement skills (FMS) develop in early childhood during the preschool years. Preschool has been noted as the critical time period within which children best develop FMS (Goodway & Branta, 2003:36; Draper *et al*., 2012:137). Hardy *et al*. (2010:504) define the preschool years as a prime time for the introduction of FMS, because children at that age do not have movement patterns that are fully fixed. Researchers highlight the need for the education system to give them opportunities within the curriculum to develop successful FMS. Free-play opportunities and structured programmes must be added into the education setting (Hardy *et al*., 2010:504; Logan *et al*., 2011:306). Deli *et al*. (2006:6) argue that FMS can be developed through physical education classes which include age-appropriate and fun activities. Pellegrini and Smith (1998:577) discuss the function of play with regard to motor skills development, muscle, strength and endurance development. Children in preschool who are given ample opportunities to play and be vigorously active will benefit in terms of motor development, as well as cognitive and social skills (Pellegrini & Smith, 1998:592).

The development of FMS is imperative for future success in motor activities and in sport (Van Beurden *et al*., 2002:245; Goodway & Branta, 2003:36; Hardy *et al*., 2010:503; Logan *et al*., 2011:305; Draper *et al*., 2012:137). Fundamental motor skills form the basis for the development and refinement of even more complex movements (Malina, 2004:54). The achievement of FMS gives the child the opportunity to interact and explore with his or her environment (physical and social) (Deli *et al*., 2006:6; Hardy *et al*., 2010:503). After the development of FMS children learn to apply their basic motor skills within sport, games and other physical activities (Logan *et al.,* 2011:305; Draper *et al*., 2012:137). The failure to master basic FMS may ultimately serve as a barrier to participation in physical activities (Van Beurden *et al*., 2002:245).

School readiness

Prior *et al.* (2011:3) define school readiness as knowing when a child is maximally ready for school learning. School readiness is a term that refers to the child's readiness to benefit optimally from the educational activities offered in the school setting. It means the child is ready and can receive the best possible start to his or her school career (Janus & Offord, 2007:2,–4). A large number of children (25% or maybe even more), show problems that do not necessarily qualify as critical enough for clinical intervention, but these problems do have an effect on the child being able to take full advantage of the education offered (Janus & Offord, 2007:1).

School readiness assessments like the *Early Development Instrument* (EDI) consider five domains when assessing a child's readiness for the school setting, these are: physical health and well-being; social competence; emotional maturity; language and cognitive development; communication skills; and general knowledge (Maxwell & Clifford, 2004:2 Janus & Offord, 2007:1). School readiness is not simply an academic or cognitive concept, but a holistic one, involving these five domains (Janus & Offord, 2007:4). Maxwell and Clifford (2004:1) discuss the involvement of families, early environments, schools, communities and interactions with other people within school readiness.

The first years of formal schooling are very important and set the scene for later years in a child's school career. The criterion given for school entry is chronological age, without specific regard to the physical, social, emotional, cognitive and communication development of each individual (Prior *et al.,* 2011:4). However, important emphasis must be placed on these afore-mentioned characteristics of actual readiness (beyond chronological age), in order to ensure success for learners in school. A child's early success is a valuable predictor of that individual's success later in their school career (Prior *et al.*, 2011:4). Difficulties in early school years have long-term consequences; problems shown in the Grade 1 tend to intensify over the years to the third grade rather than dissipate (Janus & Offord, 2007:2). Pagani *et al.* (2010:984) discuss the alarming consequences of an individual's characteristics and success in kindergarten (Grade R), predicting success in early school-going years, which significantly estimates academic achievement at age 22. Children who were less successful in kindergarten and early school years, were less successful academically at the age of 22.

School readiness includes developed motor skills, both gross motor and fine motor (Pagani *et al.,* 2010:985). Janus and Offord (2007:4) included motor skills within their assessment tool, noting that most assessments only included fine motor skills (holding a pencil, drawing and writing, copying), and should also include gross motor skills also (running, jumping, hopping). Sherry and Draper (2013:1293) discuss the positive influence that a gross motor skills intervention can have on school readiness of disadvantaged children with developmental delays in early childhood. The current study focuses on gross motor skills and how optimal development in gross motor skills can influence the improvement of school and academic activities, which could improve perceptions of school readiness.

Underlying factors

Many underlying factors have been identified as having links to academic performance in reading and writing (VMI). Laterality, directionality, midline crossing abilities, as well as problems within the vestibular and visual systems are named by Cheatum and Hammond (2000:101, 110, 116, 150, 162, 263), as influencing a child's ability to read and write. Other research lists postural control and upper body coordination and stability as important factors that could influence writing and reading performance in a child (Oliver, 1989:115; Marr & Cermak 2002:663; Van der Merwe *et al*., 2011:4; Van Jaarsveld *et al*., 2011:6). Motor control and motor planning, as well as the coordination of muscles involved in eye movements, are also stated as imperative to successful reading and writing (Dankert *et al*., 2003:542; Van Jaarsveld *et al*., 2011:6; Wajuihian & Naidoo, 2011:92). Proprioception, the visual systems, tactile, and vestibular systems all play a role in the reading and writing process (Dankert *et al*., 2003:542; Feder & Majnemer, 2007:313; Van der Merwe *et al*., 2011:4).

The current study and the intervention thereof, focuses on a handful of these underlying factors related to VMI and academic performance in reading and writing. These will be discussed in the following sections.

Laterality

Cheatum and Hammond (2000:100) describe laterality as an "internal awareness that there are two sides of the body and that these sides are different". Children have an understanding that they have similar body parts that are on different sides of the body. While not being able to name the two sides (left and right side), they merely have an understanding that they have two arms or two legs (Cheatum & Hammond, 2000:101). Basic knowledge of left and right begins at around four years according to Cheatum and Hammond (2000:101), this knowledge and ability to identify the left and right sides of the body becomes fully developed at about eight to nine years of age. Ofte and Hugdahl (2002:714) found that older children (12 to 13 years), scored higher on right-left discrimination than younger children (7 to 8 years). Auer *et al.* (2008:428) describe the development of laterality in children in terms of egocentricity (using the words “left” and “right” within their own body), and alter-egocentricity (using the words “left” and “right” to identify the sides on someone else). Correct egocentric identification of right and left occurs at around seven years of age, and alter-egocentric identification of right and left occurs at around eight to nine years of age (Auer *et al.*, 2008:428).

The ability to discriminate between right and left is important for academic tasks, particularly in the early school years (Ofte & Hugdahl, 2002:707). School tasks like reading, writing and mathematics, as well as spoken directions as to where the child should be seated, or directions for finding objects, all require the child to understand the difference between left and right (Ofte & Hugdahl, 2002:707). Specifically in reading the child must understand that they should read from left to right across the print (Cheatum & Hammond, 2000:101). Ofte and Hugdahl (2002:716) discuss the ability to predict a child’s reading disability or problems if they show right-left discrimination difficulties. The development of laterality also allows a child to separate the limbs and sides of their body, and use them to perform opposite tasks, defined by Feder and Majnemer (2007:314) as asymmetrical movements. Writing requires the child to use one hand to hold the paper and the other hand to write (Cheatum & Hammond, 2000:101; Feder & Majnemer, 2007:314).

Looking at laterality in a gross motor sense within physical education, the internal awareness of a left and right side will help a child to use one side, the other side or both sides when performing a movement; movements like catching a ball with the left, right or both hands can be executed successfully (Cheatum & Hammond, 2000:101). When children attempt to orientate themselves in their environment, they will require the knowledge of right and left, by understanding their orientation of themselves relative to the right or left of another individual, objects or space (Ofte, 2002:213). These gross motor features of right and left discrimination can occur in the school setting in either a physical education classroom or on the playground.

After children have formed an awareness of right and left within their own body, they form an understanding of left and right in relation to other objects (or people). Children need to learn the concept of discriminating between right and left when referring to a person who is facing them (Ofte & Hugdahl, 2002:707). When transferring the knowledge of right and left onto a person or picture of a person, the child learns to mentally rotate the person or image, so that he or she can take the perspective of the other person and more easily discriminate between the right and left sides (Oft & Hugdahl, 2002:708).

Directionality

Directionality can develop successfully only once a child has learnt a sense of laterality because directionality requires a child to transfer his or her understanding of a left and right side of their body into the space around them (Cheatum & Hammond, 2000:115). Three references are involved within directionality, namely: right and left; up and down; and in front of and behind (Cheatum & Hammond, 2000:115). Both laterality and directionality develop from a good sense of body awareness; the child's mental picture of his or her body which is used to understand information about his or her body, and the environment he or she is in (Sherry & Draper, 2013:1303). This mental picture helps children understand where they are spatially in relation to things around them using the afore-mentioned references such as up, down, left, right, in front of and behind (Sherry & Draper, 2013:1303). Sherry and Draper (2013:1303) state that children must have a good understanding of these references in the three-dimensional space before they are able to transfer the knowledge into two-dimensional images such as letters written on paper.

In an academic setting, directionality is an important skill to have mastered, especially when referring to reading and writing. Many children have difficulties distinguishing between letters that look very similar like *b* and *d, t* and *f* and *p* and *q* (Cheatum & Hammond 2000:117). These letters are similar, but differ in the directions of certain parts; in the case of *b* and *d* the round part faces different directions, and with *t* and *f* the rounded head is either at the bottom or the top.

Lust and Donica (2011:562) tested participants' handwriting readiness using, among other tests, one that requires the child to write letters. These letters were assessed using four criteria, including orientation or correct directionality of the letter written. Lust and Donica (2011:563) performed a multisensory intervention and they highlighted the importance of body awareness and directional concepts by including directional activities in their intervention programme. Lonigan *et al.* (2000:597) refer to 'print knowledge' as a component of early literacy skills. An aspect of print knowledge is the understanding of characteristics of print, such as (the) left to right and top to bottom orientation of print on a page (Lonigan *et al.*, 2000:597). Diamond *et al.* (2008:469) also discuss print procedural knowledge, as being the knowledge that print on a page reads left to right, and starting from the top to the bottom of the page, with specific understanding that reading begins at the top left side of the page. McBride-Chang *et al.* (2011:257) state that reading requires a child to give visual attention to the top, bottom, left and right of the characters to be able to distinguish between them.

Upper body strength and coordination and postural control

For the purpose of the current study, upper body coordination and strength will include postural stability/control, with most of the intervention activities focused on upper body stability aiming to improve arm strength along with postural stability and core strength.

Posture can be seen as the coordination of different sections of the body in order to promote balance, maintaining a stable condition at any time (Legrand *et al*., 2011:96). Westcott *et al*. (1997:630) define postural control as the ability to control the centre of mass over the base of support within the body, thereby maintaining balance while performing actions and preventing falls. For an individual to uphold equilbrium and postural control, the sensory system must collect information from the body and then produce muscle action in order to balance all the forces within the body (Barela *et al.*, 2011:1820).

A child will develop numerous strategies in terms of postural control and he or she must choose the best strategy in each situation when imbalance occurs (Legrand *et al*., 2011:96). Postural control has been described as an automatic process; however, literature shows that maintaining posture while performing an additional task deviates attention from maintaining balance and results in postural sway particularly in children (Legrand *et al.*, 2011:96). Children with difficulties maintaining postural control will have difficulty performing daily activities in an academic setting, like sitting at a desk while writing or reading. It can become particularly difficult to maintain postural control when a child is performing a secondary task that needs focus and attention; the secondary task (writing at a desk for example), diverts attention from postural control (Bucci *et al.*, 2013:3728). Children with motor problems may have dysfunction with regard to postural control and they may struggle to maintain a sitting or standing position on their own (Westcott *et al*., 1997:630).

Lust and Donica (2011:560) list posture as an important requirement for legible handwriting in a child to be achieved successfully. Marr and Cermak (2002:663) specifically included postural control activities in their intervention program, highlighting this as an important factor within handwriting and visual-motor integration performance.

Motor planning and coordination

Motor planning as defined by Cheatum and Hammond (2000:193) is:

> "… the ability to plan, organize and complete a series of movements that are directed toward some purpose".

Motor planning occurs before the movement can occur. The child must rely on his or her senses to evaluate the situation and decide on the correct amount of muscle force and timing of this force; i.e.: the muscle *plan*, so that the action can be completed successfully (Cheatum & Hammond, 2000:193). Sober and Sabes (2003:6982) divide motor planning into two processes. Firstly one decides on a movement trajectory while referring to visual information, secondly one transforms the movement trajectory into a motor command within the appropriate body part. As a child repeats actions over and over successfully, they become automatic, and as the child attempts more complex movements they can more easily perform the new skill if it has similar characteristics to the practised skills (Cheatum & Hammond; 2000:194).

Handwriting is a process that requires continuous motor planning, as the process of learning to write is a new and unfamiliar skill (Cornhill & Case-Smith, 1996:733; Feder & Majnemer, 2007:314). The child needs to think about and plan how he or she will move his or her hand to form the letters with the pencil. Cornhill and Case-Smith (1996:733) note that motor planning guides the child to sequence, plan, and execute letter formation and the order of letters in words. Motor planning is linked to proprioceptive awareness; if a child has no awareness of their body position or movement they will have difficulty planning hand movements (Cornhill & Case-Smith, 1996:733).

Proprioception

Proprioception provides the knowledge of where one's limbs are in space while in a static or dynamic situation (Goble *et al.*, 2005:156). Proprioception gives a sense of the body's position and how it is moving without relying on vision (Goble *et al.*, 2010:54). Receptors in the skin, joints, muscles, tendons and underlying tissues provide information as to the body's position (Cheatum & Hammond, 2000:185; Goble *et al*., 2010:54).

Dankert *et al.* (2003:542) describe visual-motor skills as multi-faceted, with underlying factors influencing a child's ability to perform pencil and paper activities; one of the factors they mention is proprioception, or kinaesthesia. Cornhill and Case-Smith (1996:733) describe kinaesthesia as:

> "… the awareness of weight of an object (and of a limb) and the directionality of joint and limb movement."

Lust and Donica (2011:560), too, allege that kinaesthesia or proprioception is an important factor that helps with the handwriting process.

Proprioceptive feedback is important for coordinated movement; it helps to control muscle forces, timing of the different limb segments during movement, the trajectory of the movement, and provides an internal representation of the limb all of which helps with adaptation of the movement (Goble *et al.*, 2005:156). Proprioceptive awareness, therefore, helps learners understand where their hand is on the desk and in relation to the page, how it is holding the pencil and how they are moving the pencil to form the letter.

Cornhill and Case-Smith (1996:733) state that proprioceptive input and awareness is imperative for efficient handwriting as it influences the amount of pressure a child applies to the writing implement, provides information on direction of the movement during letter formation, and they also suggest that it could be more efficient than visual perception during writing due to the immediate and specific feedback the proprioceptive system allows. Feder and Majnemer (2007:314) add that the proprioceptive system influences the child's pencil grip and the amount of pressure applied to the pencil, as well as the child's ability to write within the line boundaries. Bara and Gentaz (2011:750) investigated the role that proprioceptive and haptic (touch) exploration of letter shapes could play in improving handwriting skills. It was found that training sessions involving visual perception, proprioceptive perception and haptic exploration of letter shapes, were more effective in improving handwriting as opposed to merely visual exploration (Bara & Gentaz, 2011:752). The haptic exploration of the letters allowed for a more comprehensive and accurate perception of the letter as it involved perceptual and motor learning (Bara & Gentaz, 2011:752).

Automaticity

According to Samuels and Flor (1997:107)

> "Automaticity refers to the ability to perform complex skills with minimal attention and conscious effort."

When an individual practises a task to the point of the task becoming automatic, it allows that individual to perform additional tasks more easily because attention is no longer needed for the initial task (Samuels & Flor, 1997:108). Barela *et al*. (2011:1814) described lack of automaticity as a difficulty in performing a task without having to concentrate and pay a great deal of attention to the task at hand. When an individual performs two tasks simultaneously (a primary and a secondary task) it puts pressure on the available pool of cognitive resources; each task no longer has access to the optimal amount of resources available to them and they have to share the resources (Olive, 2003:2). The primary or secondary task performance is negatively affected with this added pressure on the cognitive system (Olive, 2003:2).

Barela *et al*. (2011:1815) discuss the difficulties dyslexic children face when attempting to be successful in reading and writing tasks, because these tasks require the child to maintain balance and postural control throughout the activity. They describe the process of postural control as natural and automatic and should not require much cognitive attention (Barela *et al*., 2011:1815). Barela *et al*. (2011:1815), and Bucci *et al.,* (2013:3727), both discuss the postural control process as the integration of sensory information with motor control; the sensory system needs to give feedback on the position and sway of the body while the motor system must correct any imbalances detected and this process must occur easily and automatically. This process does not occur automatically in many children.

Dual tasks can be defined as tasks that include cognitive and motor aspects that are performed simultaneously (Höglund & Norrlin 2009:424; Olivier *et al*., 2010:494). Studies that assess dual-task paradigms measure participants' ability to maintain postural control in various settings while being given a secondary task (usually cognitive) at the same time (Höglund & Norrlin, 2009:425; Olivier *et al*., 2010:495; Barela *et al*., 2011:1815; Bucci *et al*., 2013:3729). For the purpose of the current study handwriting and reading will be seen as dual-tasks. Children in preschool are beginning to learn to read and write; these are complex tasks that require much cognitive attention. If a child needs to continually give attention to underlying gross motor processes he or she will not be able to give optimal attention and concentration to the reading or handwriting process. Visual-motor integration skills allow a child to fluidly and legibly produce letters when writing; if letter formation is difficult children are forced to concentrate on the motor aspects of writing rather than aspects such as spelling and content formation (Mäki, 2001:644). With practice, children's handwriting can become automatic and free attention that is required for higher writing processes (Bara & Gentaz, 2011:746).

Children have limited attention capacity and this can hinder their ability to perform dual-task activities; if the attention demands are higher than their capabilities, they find it difficult to perform tasks simultaneously (Olivier *et al*., 2010:498). Olivier *et al*. (2007:817) state that the development of attention and ability to complete dual-tasks increases as children get older; with six to eight year old children struggling with a dual-tasks, while 11-year old children had less difficulty. Children in preschool (aged four to six years), as used in the current study's sample, are young enough to have notable difficulties with attention and dual-tasks.

Walking is an everyday task that most individuals perform; it can be seen as an automatic activity that requires very little cognitive effort (Cherng *et al*., 2007:231). If walking is an automatic process, then performing an additional task concurrently would not have any effect on the success of walking, but if walking is not entirely automatic the secondary task will steal attention from the walking task and sway or imbalances could occur (Cherng *et al*., 2009). Children develop an automatic adult-like walking stance, with fully developed balance and gait characteristics by the age of seven years, therefore, children under the age of seven can be seen as having not yet completely developed or automated the walking process (Cherng *et al*., 2007:232). Cherng *et al.* (2007:236) found that children in preschool (four to six years old) had difficulty maintaining their normal walking pattern when performing a secondary motor or cognitive task.

Underlying gross motor tasks, as discussed previously, need to become automatic processes. If a child can perform upper body coordination and postural control, laterality, directionality, motor planning and proprioception skills optimally and automatically, he or she will be able to reach the cognitive attention demands required to learn to read and write.

The following section will describe the influence of socio-economic status on VMI skills.

Socio-economic status

South Africa (SA) is a developing country and has been described as having great socio-economic disparities; therefore, the concept of socio-economic differences within South African children is a topic that must be addressed (Pienaar *et al*., 2013:371). Taylor and Yu

(2009:9) investigated the relationship between socio-economic status and education in SA compared to other parts of the world, and found that SA was the lowest scoring country in terms of reading literacy scores. Socio-economic status (SES) explains the large amount of variance in reading skills scores of South African scholars, with some scholars being effectively illiterate (Taylor & Yu, 2009:12,49).

Visual-motor integration, along with reading and writing has been shown to be sensitive to SES. Visual motor integration scores increase as SES increases (Lotz *et al.,* 2005:64; Dunn *et al*., 2006:952). Dunn *et al*. (2006:956) found that VMI scores were related to SES when they found significant differences between lower, middle and higher socio-economic groups in the DTVMI. Singh and Franzsen (2011:42) emphasised the difference between children from various socio-economic backgrounds in VMI skills. Children from low- and low-to-middle socio-economic backgrounds scored lower than the middle and higher socio-economic background groups. Bara *et al*. (2007:645) and Gentaz *et al*., (2013:5) emphasise the relatively poorer reading abilities of children with low socio-economic background. Children from lower socio-economic backgrounds have reading readiness problems due to lower frequency of reading activities at home, as well as limited reading material available at home (Bara *et al*., 2007:645).

Within the South African context, the effects of SES has been researched a number of times with various conclusions being drawn. Many children in SA attend poorly resourced and overcrowded schools and live in poverty-stricken homes or areas, which influences their early childhood development negatively (Dunn *et al*., 2006:952). Singh and Franzsen (2011:43) found that children from institutions of lower socio-economic level were exposed to fewer resources such as toys, and this affected their VMI scores. Taylor and Yu (2009:34) refer to parental education, absenteeism, school SES and shortages in school resources as some factors negatively affecting reading ability in SA. Parents with higher levels of education are able to give more home support to children and are able to help with homework and support their child's school endeavours more readily than lower socio-economic parents with lower education levels (Taylor & Yu, 2009:6). Schools of lower SES had fewer resources, for example, a well-stocked library, and this had an effect on the reading skills of the scholars (Taylor & Yu, 2009:34). Absenteeism is said to be a major concern for schools of lower SES, and this negatively affects levels of reading literacy scores of scholars (Taylor & Yu, 2009:34). Family background in SES along with the SES of the schools learners attend are acting as hurdles to academic achievement, obstructing learners from achieving results that may well be within their reach (Taylor & Yu, 2009:52). Environmental stresses of poverty that influence children's development can be fewer educational resources, poor parenting strategies and disorganized home environments (Pienaar *et al*., 2013:371).

Goodway *et al*. (2003:309) propose that children who grow up in low socio-economic areas have less access to safe outdoor playing areas, which limits their opportunities for movement skills development. Therefore it can be said that children from disadvantaged backgrounds have fewer opportunities to develop school readiness skills when compared to advantaged peers (Grissmer *et al*., 2010:1016). The gaps between advantaged and disadvantaged children need to be addressed before school entry in order to minimise the growing gaps between these two groups of children (Grissmer *et al*., 2010:1016).

Gender differences

Differences between boys and girls in academic literacy skills and gross motor skills have been widely researched and reported with varying results (Soderman *et al*., 1999:13; Mäki *et al*., 2001:667; Junaid & Fellowes, 2006:8; Mewdell & Wray, 2008:43; Hardy *et al*., 2010:506; Kordi *et al*., 2012:359; Tsapakidou *et al*., 2014:4). Soderman *et al.* (1999:14) notes that these differences amongst boys and girls should be recognised and respected within the preschool classroom, and children should not be negatively labelled because of typical lags in performance or development.

Mäki *et al.* (2001:665) concluded that at entry into school, girls had better writing readiness skills (like VMI skills) than boys and were, therefore, ahead of boys when learning to write. Medwell and Wray (2008:43) state that more boys have handwriting difficulties than girls. Soderman *et al*. (1999:9) discuss the differences between boys and girls in skills that pertain to early literacy; skills like visual memory, verbal memory, directionality, saccades, VMI and reading were tested. It was found that in every aspect of literacy tested, girls scored higher than boys, although not all differences were statistically significant (Soderman *et al*., 1999:13). Girls scored significantly higher than boys in reading skills and visual memory skills, as well as directionality and saccades (Soderman *et al*., 1999:13). Junaid and Fellowes (2006:8) found that girls scored significantly higher in manual dexterity tasks in the Movement Assessment Battery for Children test (including a pen and paper task of a drawing a line within a trail), than boys did. As girls tend to have better pre-writing skills than boys as early as preschool level, it may be important to detect and remediate deficits in VMI and other writing skills in boys as early as possible (Mäki *et al*., 2001:667).

When referring to gender differences in gross motor skills and development, research shows varying conclusions. Differences have been noted in certain skills (object control), while other (locomotor) skills have been reported to be homogenous between genders. In terms of the gross motor tests used in the current study, Ulrich (2000:54-56) provides a single set of age norm information for locomotor skills, but a separate set of norms for boys and girls for object control skills; which highlights the differences between boys' and girls' gross motor skills. The second edition of the TGMD was improved by adding these separate object control normative tables for boys and girls, in order to address the differences found in average raw scores between the genders (Ulrich, 2000:viii).

Other research on fundamental gross motor skills and development differences between boys and girls both supports and opposes Ulrich's (2000) evidence. Supporting Ulrich (2000) differences between the genders in locomotor skills have been found to be non-existent by other researchers (Kordi *et* al., 2012:359; Tsapakidou *et al*., 2014:4). While some researchers found that girls were better than boys in locomotor skills (Cliff *et al*., 2009:11; Hardy *et al*., 2010:506). Regarding object control skill boys have been found to perform better than girls, which agrees with TGMD-2 normative information (Ulrich, 2000; Okely & Booth, 2004:368; Junaid & Fellowes, 2006:8, Hardy *et al*., 2010:506). However, some researchers have found that boys and girls object control skills are similar (Cliff *et* al., 2009:11; Kordi *et al*., 2012:359).

Physiological attributes of boys and girls have also been discussed as factors influencing differences in motor skills and development. Physiological characteristics like size, strength, growth and maturation have been named as possibly affecting differences in motor skill development and acquisition (Thomas & French, 1985:260; Junaid & Fellowes, 2006:6; Hardy *et al*., 2010:506). An example given by Thomas and French (1985:276) shows that the large differences between boys and girls throwing for velocity skills are persistent from as early as three years up to and after puberty. This difference in ability to throw for velocity (as far or hard as one can), could be linked to boys' arm strength, musculature and size (Thomas & French, 1985:276). However, physiological characteristics are very similar between boys and girls before the onset of puberty and thus many researchers have suggested that gender differences in motor skill development pre-puberty cannot be attributed to differences in physical characteristics (Thomas & French 1985:260; Junaid & Fellowes, 2006:6). Thomas and French (1985:260) refer to gender *sameness* prior to puberty. Gender differences in preschool children are more likely to be the result of different socialization which arises from time spent with parents, teachers and peers (Hardy *et al*., 2010:506).

Researchers have also tried to explain these gender differences within a psychological and social framework. Garcia (1994:213) describes gender as a social factor that affects a child's movement behaviour and sport participation. Children are expected to behave a certain way according to their gender, and these expectations develop early in childhood and often are dependent on interactions with the same-sex parent (Garcia, 1994:213). Children form gender roles early in childhood; they form an understanding of appropriate gross motor play behaviours and types of toys for their gender (Thomas & French, 1985:261). Socialization into different gender roles and segregated worlds begins with parents; fathers play more with their sons than with their daughters, and parents engage in different levels of physically vigorous play with their sons and daughters (Pellegrini & Smith, 1998:581). Although the differences between boys and girls in preschool are not large, they are most probably generated by social factors (Thomas & French, 1985:261).

Thomas and French (1985:261) regard a child's family, peers, teachers and coaches as important sources for learning gender roles in terms of motor skills performance. Boys are encouraged through characters in their environment (parents, teacher or coaches), to participate in certain types of sport (utilising ball skills), which may lead to their generally more advanced object control skills (Okely & Booth, 2004:370). Okely and Booth (2004:370) question whether girls would be equally proficient in object control skills if they were also provided with the same opportunities, instruction and encouragement for playing ball skill types of sport. Okely and Booth (2004:370) found a similar result and conclusion for skipping skills; girls were found to be more proficient in skipping than boys and this could be explained by the different cultural expectations provided, allowing girls enthusiastic access to activities like dance and gymnastics that practise a large amount of skipping. Thomas and French (1985:275) discuss how the differences found in boys' catching skills, for example, are likely to be due to environmental and socialization factors, where boys are given more opportunities and encouragement to practise these types of tasks. In this regard Queiroz *et al.* (2014:30) found that differences between the genders were non-existent in populations where girls were given equal access to the sporting opportunities boys were given.

Intervention

The key to interventions focusing on VMI skills is to detect and remediate deficits as early as possible in a child's school career, preferably before formal schooling commences. Dunn *et al*. (2006:951) highlights the need for VMI skill deficits to be detected as early as possible so that interventions can take place early on in the child's school career. Pienaar *et al*. (2013:376) alleges that perceptual-motor skills, like VMI, are important building blocks for later school years and should, therefore, be a main focus of preschool years. Interventions in the early school years will help to prevent negative experiences in the later school years (Marr & Cermak, 2002:662). Visual-motor integration skills should be remediated as early as possible in a child's school career to enable them to cope with school demands and decrease lags between them and their peers (Ratzon *et al*., 2009:1174).

Since VMI is a multifaceted skill, the intervention programme should include multi-faceted activities. Dankert *et al.* (2003:543,-548) discuss the need for multi-faceted intervention strategies when attempting to improve visual-motor skills. Dankert *et al*. (2003:545) included fine motor, gross motor and visual-motor and visual perception activities within their intervention programme. Dibek (2012:1927) developed another effective multi-faceted intervention that included reading of stories, acting out of the stories and playing with 3-D models and board games related to the stories, and completing pen and paper worksheet activities related to the story.

Lust and Donica (2011:562) highlight the need for a multi-sensory intervention programme when attempting to improve the handwriting skills of children and the superiority of a multi-sensory intervention programme over the simple direct practise of handwriting activities. Multisensory activities discussed included playing, singing, motor skills, body awareness, sensory processing and visual-perceptual skills (Lust & Donica, 2011:561). Specific activities like drawing big letters onto the blackboard, tracing letters in various multi-sensory substances, tracing letters in the air and forming letters with modelling clay are discussed within a multi-sensory intervention programme for elementary school children (Lust & Donica, 2011:561). Bara *et al.* (2007:644) discuss the effectiveness of a multi-sensory intervention program when learning to read. Pre-reading interventions should include practise of the visual, haptic (proprioceptive and touch), auditory and movement systems because all these systems play a role in reading (Bara *et al*., 2007:644).

The current study focused primarily on a gross motor intervention programme on the premise that VMI skills (as related to reading and writing), have multiple underlying influencing factors (as discussed previously). No research was found that exactly replicated the current study's use of a predominantly gross motor intervention programme to improve VMI skills.

CHAPTER THREE

METHODOLOGY

INTRODUCTION

In order for researchers to be scientific in their search for knowledge and solutions to perplexing problems, systematic methods must be followed in order to maintain integrity within the academic faculty. Kothari (2004:1) and Thomas *et al.* (2011:12-14) describe the systematic and scientific methods involved in scientific research as: naming the problem; forming a hypothesis; collecting the data; analysing the data and reaching conclusions about the topic either in the form of a solution to the problem or forming a generalisable theory.

Research within the education setting differs from the hard-sciences like biology or chemistry (Odom *et al.*, 2005:139). The educational setting is complex with many factors influencing how participants react and interact within any given study. Hard-sciences have a much easier job describing and finding homogenous, predictive results when nature shows so much more regularity than humans do (Berliner, 2002:19). Within the educational setting a myriad of interactions take place, for example, the student's characteristics (IQ, motivation, socio-economic status (SES) and attention), interact with the teacher's characteristics (training, beliefs about assessments and learning concepts and perhaps even the teacher's mood or personal happiness). These things interact with influences such as the curriculum being taught, SES of the community and peer effects within the school (Berliner, 2002:19).

Experimental research is a scientific research approach that includes manipulation of treatments with the hopes that a change will be brought about in the participants and a causal relationship will be found (Thomas *et al.*, 2011:21). Kothari (2004:5) states that an experimental approach to research is characterised by the manipulation of some variables in order to observe how those variables affect other variables. A researcher formulates a hypothesis regarding the effect a treatment may have on a certain population and investigates whether the hypothesis can be proved or not through a treatment or intervention programme carried out on a sample of the population.

In order to prove a causal relationship, the researcher must control all extraneous factors apart from the experimental variable (the focus of the study). Only then can the researcher deduce that the change that occurred happened because of the independent variable (type of programme or treatment) (Thomas *et al.*, 2011:21). Thomas *et al.* (2011:330) describes nine factors that must be controlled as much as possible in order to be able to draw conclusions regarding the effect of the treatment programme. Three of these are imperative to consider within the current study, namely: history; maturation; and testing. History refers to the effect that an occurrence of an unintended event may have on participants' abilities; maturation refers to the effect that aging or developing may have on participants' abilities (which is important when dealing with preschool children at a critical time of development), and testing refers to the problem that taking a test once may benefit a participant's performance on the second attempt of the test (a learning effect) (Thomas *et al*., 2011:332). Within the current study's methodology these factors have been controlled as much as possible. In the interpretation of the data these factors have been carefully considered before conclusions were made.

This chapter outlines the methodology followed within the current study. The research problem statement is defined along with specific aims that are to be the focus of the study. The sample that participated in the study will be accurately defined. Measures used to assess the participants are clearly explained and discussed. The research design is clearly delineated along with the discussion of procedures from pre- to post-test.

RESEARCH DESIGN

This study made use of a quasi-experimental design, because the participating preschools were not randomly selected, but were selected subject to their proximity for financial and logistical reasons. Within this design quantitative data were collected from the tests used in this study.

PROBLEM STATEMENT

The primary aim of this study was to determine whether the Visual-Motor Integration (VMI) skills in preschool children could be improved through an intervention of gross motor activities.

Specific aims

1. To determine the VMI skill level of the selected preschool children.
2. To determine whether there were differences in VMI skills between preschool boys and girls.
3. To determine whether a self-designed gross motor intervention programme could improve the VMI skills.

HYPOTHESIS

The hypothesis of the current study theorizes that the visual-motor integration skills of the experimental sample can be improved through the gross motor intervention programme.

METHODOLOGY

Sample

A sample of convenience was used as the participants were chosen due to proximity and not randomly. Two preschools in the Stellenbosch region were approached by the researcher to participate in the study. As discussed in the previous chapter literature suggests that there are differences between the VMI skills of children from different socio-economic backgrounds and, therefore, one school was situated in a low socio-economic community, which is classified by the Western Cape Education Department as a Quintile 2 school, with no school fees payable by parents. The second school was situated in an area of higher socio-economic status and is an independent, private school where school fees are paid by parents. Henceforth, these schools will be referred to as the lower socio-economic and higher socio-economic schools respectively.

The Grade R learners (N=77) in the selected preschools were asked to participate in the study. Those who volunteered and adhered to the inclusion criteria were included in the study. There were more participants in the lower socio-economic status school (n=57) compared to the higher socio-economic school (n=20). After the participants' VMI skills were determined participants were excluded if their VMI skills were found to be average or above. The remaining participants (N=23) scored below average on VMI skills and were all in the lower SES school (no participants from the higher SES school qualified to participate further). The participants were randomly divided into an experimental (n=12) and control (n=11) group, and boys (n=17) and girls (n=6) were randomly distributed between the two groups.

The experimental group took part in a group-based intervention program focusing on gross motor skills. The experimental group members were divided between the two Grade R classes at the remaining school and formed two groups of 6, both groups attended separate 30-minute intervention sessions with the researcher. The control group did not participate in any specific physical activity intervention program but took part in a story-time session, listening to taped children's stories in their classroom.

Inclusion and exclusion criteria

Individuals were included in this study if they attended the participating preschools, were within the age range (4 to 6 years) and scored below average on the Developmental Test of Visual Motor Integration (DTVMI). Individuals were excluded from the study if they had severe disabilities (for example, amputations, severe cerebral palsy, blindness or deafness), or injuries that prevented them from participating in physical activity, or if they were unwilling to participate in the testing or intervention programme. If parental consent was not obtained they were also excluded from the study. If any individual did not wish to take part and did not give their assent they were excluded from the study. Individuals were excluded from the study if they participated in any other research intervention.

Place and duration of study

This study took place on the school grounds of the participating preschools. The tests were administered in an available classroom area. The intervention programme was performed in the school hall.

Statistical procedures

The statistical analyses of the results were overseen by Professor Kidd from the Centre for Statistical Consultation, Stellenbosch University.

Baseline comparisons of schools and gender were done using 2-way factorial ANOVA. Comparisons of the experimental and control groups from pre- to post-testing were done using mixed model repeated measures ANOVA. Group and time were treated as fixed effects and the subjects as random effects. Post hoc testing was done using Fisher least Significant Difference (LSD) testing. Summary statistics were reported as means with standard deviations. A 5% significance level ($p<0.05$) was used as guideline for significance testing.

Ethical aspects

Ethical clearance for this study was obtained from the Research Ethical Committee of Stellenbosch University (HS1013/2013). Thereafter, permission for the study to commence in the schools was obtained from the Western Cape Education Department (WCED). Permission from the principal of the schools and the head teachers of the Grade R classes was obtained, after permission had been received from the WCED.

Each participant's parent or legal guardian was asked for their signed informed consent for their child to participate in the testing and intervention procedures. The procedures were explained to the children in a language that they understood and each child was asked to sign an assent form; giving their consent and willingness to participate in the testing and the intervention procedures. If the individual did not wish to participate, they were not forced to do so.

Participants were supervised at all times during the intervention sessions by the researcher and the teachers were on hand at all times. The school's injury protocol was followed in case of an injury. The researcher is a qualified Kinderkineticist registered with the South African Professional Institute for Kinderkinetics (SAPIK no: 01/013/03/1314/005), and is sufficiently qualified to present the intervention programme to the individuals.

PROCEDURES

In this study, two standardised tests were performed before and after the intervention programme. The subjects performed the Beery-Buktenica Developmental Test of Visual-Motor Integration, 6^{th} Edition (DTVMI) (Beery & Beery, 2004), and the Test of Gross Motor Development, 2^{nd} Edition (TGMD-2) (Ulrich, 2000). The intervention program took place over 14 weeks, with two sessions per week.

Beery-Buktenica development test of visual motor integration

The Beery-Buktenica Developmental Test of Visual Motor Integration (DTVMI) is designed to measure the VMI skills of individuals aged between 2 to 100 years (Beery & Beery, 2004:15). The test measures the degree to which a person can integrate their visual perception and motor abilities. The DTVMI can be administered by anyone with a qualification in childhood education or similar field (Beery & Beery, 2004:1,17).

There are 3 testing methods described within the testing manual. Each of these methods (Table 3.1) are said to be successful as a screening tool for VMI skills of preschool children (Beery & Beery, 2004: 20).

TABLE 3.1: **TESTING METHODS (DTVMI)**

Basic Methods	Advantages	Disadvantages
A: 2 or more adults with 20+ children at one time	Faster (20 minutes), inexpensive	Less time to observe
B: 1 or 2 adults with 2+	More observational	Several times method A's cost

children at a time	information	
C: 1 Adult with 1 child at a time	More diagnostic information	20+ times method A's cost

Source: Adapted from Beery and Beery (2004:20)

Beery and Beery (2004:20) suggest method A for screening preschool children as the most effective method, when including a good follow-up with a specialist in child development. They suggest that method A be followed and then method C be used during the follow-up testing with the specialist. In this study this procedure was followed. Method A was used to screen the participants on their VMI skills, using the DTVMI screening test. They completed the test in their classes of about 30 children. Two qualified persons administered the test, the investigator (SAPIK no: 01/013/03/1314/005), and an occupational therapist (OT0067628). This allowed for more in-depth monitoring of the participants. Once the screening tests had been scored and the results interpreted, the occupational therapist (OT) was able to identify participants who had a VMI skills deficit. These participants then completed the 2 supplemental tests of the Beery VMI using method C, one-on-one observation with the same examiners.

Testing took place in a classroom with the participants' at their school desks, after ensuring that their desks and writing areas were comfortable and posed no obstacles for writing or drawing. The following testing procedure steps were followed as described by the test manual and the instructions were given to the children as stipulated by the manual (Beery & Beery, 2004:20-24). For a more detailed explanation of the following steps see Appendix A (pp:87)

1. The DTVMI Full Form test booklets were distributed to the participants along with a sharpened HB pencil with no eraser.
2. It was ensured that each participant was sitting centred to their desk, with the booklet centred and squared to their body.
3. In the current study, to ensure the test was completed fully, the procedure for individuals below the functional age of 5 was followed during all tests. This means the participants began with Item 4 on page 2. The researcher demonstrated the drawing of a top-to-bottom vertical line in the space provided in the booklet for each participant, and gave instructions to reproduce the line. The researcher then moved

around the class in the same way producing the next 2 items, the horizontal line and the circle.

4. The researcher then instructed the participants to open their booklet on the next page. This was demonstrated and the page was shown to the class.
5. The researcher explained to the participants that they must copy the forms in the space provided below each form. The researcher explained that they must begin with Item 7, and Item 7 was shown to the participants.
6. The participants were encouraged to try their best on each form and not to skip any. The researcher also instructed the participants to make only 1 attempt on each form and not to erase anything. This was repeated as necessary.
7. The participants were allowed to continue attempting to reproduce the forms until each felt they had completed the booklet.

The researcher and OT watched each individual closely and noted their attitude to the task and how they approached the task, their body position, movements and any other potentially important behaviour during the test (Beery & Beery, 2004).

Scoring

The scoring on the DTVMI follows the scoring from previous editions of the test. The participant receives 1 point for each item he or she copied correctly, the test and scoring stops once the individual reaches 3 consecutive failed attempts at reproducing the shapes (Beery & Beery, 2004:26). A brief summary of scoring aspects will now be discussed.

Marking and scribbling

The first 3 items of the DTVMI are imitated and spontaneous scribbling or marking tests. These tests are only administered in children well under the functional level of 5 years old. In this study these tests were not necessary. The children were all over the age of 5 years and, thus, it was assumed that the participants could perform these three tasks and, therefore, the participant automatically received a point for each of tasks 1-3 (Beery & Beery, 2004:29).

Criteria

The DTVMI scoring is based on *Score* and *No Score* criteria (Beery & Beery, 2004:27). Examples of correct and incorrect copied forms, as well as the specific criteria for the form with regards to sides of the form and angles of lines corners are provided in the test manual (Beery & Beery, 2004:30-79). Brief descriptions of the developmental age norms for each form are also provided.

The 'If in doubt rule'

Beery and Beery (2004:28) emphasise that if a scorer is "in doubt" regarding whether the form is correct or not, they should score the form correct and give the point. Caution is given to inexperienced scorers to ensure they are not too strict in their scoring.

Basal

Since the first three items of the test are not performed during group testing, it is assumed that the participant receives a score of 1 for each of these tasks. The researcher assumes that these tests would have been performed adequately if the child has adequately performed the subsequent and more difficult items (Beery & Beery, 2004:29). If the more difficult tasks, 7, 8 or 9 were not performed adequately, the researcher must administer the previous easier tasks (Tasks 1 to -6).

Ceiling

The ceiling of the test is reached when the child has failed three consecutive reproductions. The investigator may allow the participant to continue the test beyond failed attempts, if the participant wants to (Beery & Beery, 2004:29). In the current study the participants were allowed to continue until the other participants were all finished with the test. The scoring of the tasks however, stops after three consecutive failed attempts and the ceiling is reached.

Results and recording

The researcher in this case used the cover of the DTVMI form to record the results. If the participants were tested individually the researcher would have recorded the results on the Recording and Scoring sheet, which provides a short description of each age norm for each form. This is not necessary for group screening (Beery & Beery, 2004:29).

The raw scores were added up and entered onto the front cover in the space provided. The researcher then compared the participant's results to the percentile rank and standardized norms tables found in the Beery VMI test manual (Beery & Beery, 2004). The researcher then filled these scores onto the front cover in the space provided.

The participants' scores on the Beery VMI screening test were reviewed against age norms. Only the participants who scored below average for VMI skills qualified to take part in the current study. These participants (N=23) were then tested individually with the supplemental tests of *Visual Perception* and *Motor Coordination.*

Standard scores

To define a participant's score as "below average", the standard scores are used. Standard scores within the Beery VMI are defined as equal units of measurement with a mean of 100 and a standard deviation of 15 (Beery & Beery, 2004:93). Standard scores are used to be able to treat the numbers mathematically and to be able to make statistical comparisons between the DTVMI test results and to other tests or previous DTVMI editions (Beery & Beery, 2004:94). Standard scores are used to express scores in equivalent units to be able to compare them (Burton & Miller, 1998:81).

"Average" is also defined as one standard deviation (15) below or above 100 (the mean), which would be any standard score between 85 to 115 (Beery & Beery, 2004:94). For the current study this definition of "average" was used. Any standard score below 85 was defined as "below average" and those participants qualified to continue in the study.

The following are the descriptive categories that are used to describe a participant's result.

TABLE 3.2: **DESCRIPTIVE CATEGORIES (DTVMI)**

Standard Score	Performance
>129	Very high
120-129	High
110-119	Above average
90-109	Average
80-89	Below average
70-79	Low
<70	Very low

Source: Adapted from Beery and Beery (2004:94)

Supplement tests of visual perception and motor coordination

After the participants had been identified as having "below average" VMI skills, the 2 supplemental tests were performed with each participant individually. Researchers followed up the DTVMI screening test with these supplemental tests in order to determine in which domain the participant had a deficiency. A participant may have a problem solely with the *integration* of visual and motor abilities. The participant may, on the other hand, have a problem with *visual perception* skills and/or *motor coordination* (Sortor & Kulp, 2003:758; Beery & Beery 2004:16). If all three tests are administered they must be administered in a specific order: VMI; Visual Perception and Motor Coordination. A statistical and graphical representation of the three tests' results can be easily illustrated on the front cover of the DTVMI test booklet (Beery & Beery, 2004:16).

Visual perception

The following is a summary of the procedures followed during the administration of the visual perception supplemental test (Beery & Beery 2004:81-85). A more detailed version of the steps followed can be seen in Appendix B (pp:90):

1. A stopwatch was used to keep the time limit of the test at exactly 3 minutes. It must be ensured that the participant is not holding any writing implement during the test.
2. As with the VMI test, the test procedures for children under the functional age of 5 are followed, which include observing the first 3 test items.
3. The test continues with Item 4, 5 and 6, the items used as practice for the participants. The participants are asked to identify the form that is an exact copy of the stimulus form. The researcher makes a mark next to the participant's response whether it is correct or incorrect. Whether the participant's response was correct or incorrect the researcher talks the participant through each task.
4. The test then begins at Item 7, and a stopwatch is used. No more teaching of the tasks occurs beyond this point. The researcher moves through the items marking the participants' responses.
5. Any irregular behaviour, such as squinting, holding head too close to the page, rubbing of eyes or excessive talking is noted.
6. The test stops exactly 3 minutes after starting. Praise is given to each participant.

Scoring Visual Perception

One point is received for each correct response. Scoring ends when three consecutive failed responses are given, or if the 3 minute time limit had lapsed, whichever occurs first. A maximum of 30 points can be scored.

The raw score is entered into the space provided on the DTVMI test booklet. The raw score is converted into a standard score; which is also entered onto the front cover of the booklet.

Motor coordination

The following is a summary of the test procedure followed for the motor coordination supplemental test (Beery & Beery 2004:87-89). For a more in-depth discussion of the following steps see Appendix C (pp:93):

1. A stopwatch is used, exactly 5 minutes is allowed for this test. A sharpened HB pencil with no eraser is provided. The test paper must be kept straight and centred during the test.
2. The researcher demonstrates and teaches the participant how to complete the tasks using the first three items. The researcher completes Item 4A while explaining the goals of the test: draw a line connecting the dots, and stay in the "road" or between the lines. The participant then completes Item 4B exactly as the researcher did. This procedure is repeated for the next 2 practice items.
3. The test then begins with Item 7. The researcher starts the stopwatch and instructs the participant to complete the subsequent items in the same way as the first three, without skipping any. From this point onwards there is no more teaching of the items, however, brief prompting can occur to keep the participant drawing within the lines and completing the entire shape leaving no parts out.
4. The researcher does not stop the test after three consecutive failed attempts; the test is continued for the entire 5 minutes unless the participant indicates that he or she wants to stop.

Scoring motor coordination

The items of the Motor Coordination test are designed to measure the participants' ability to draw within a specified area by using his/her finger control and hand movements. The items are then scored only on whether the participants' drawings are within the 'roads'. The "if in doubt" rule is emphasised in the Motor Coordination tests; if the researcher is in doubt, they should score the item as correct (Beery & Beery, 2004:89).

The maximum score possible for the Motor Coordination test is 30. All the items are scored; the first three tasks, the teaching items and all the items completed by the child within the 5 minutes. The researcher does not stop scoring after three consecutive failed attempts (Beery & Beery, 2004:89). Each attempt that occurred within the 5 minutes is scored. Each attempt that is correct is given 1 point.

Reliability

The reliability of the DTVMI is considered by measuring 3 areas of consistency within the test: 1) content/internal consistency, 2) test-retest reliability and 3) inter-scorer reliability (Beery & Beery, 2004:103).

To measure the tests content and internal consistency, a Rasch-Wright analysis, a Spearman-Brown odd-even split-half correlation, as well as Alpha coefficients was used. Results from the Rasch-Wright analysis showed that there is item separation of 1.00 and a person separation of 0.96. This shows that the test items of the Beery VMI follow the authors' test construct direction. The Spearman-Brown analysis of the tests showed a correlation of 0.95 across the age groups, which shows a high level of internal consistency. The means of odd-even split-half correlations for age groups 2 to 17 years was 0.85 for the Visual Perception test and 0.87 for the Motor Coordination test. The Alpha coefficient analysis showed to what level the test items measure the same underlying construct. The mean Alpha coefficient across age groups 2 to 17 years was 0.82 for the DTVMI, 0.81 for the Visual Perception test and 0.82 for the Motor Coordination test (Beery & Beery, 2004:103-104).

For the 6th Edition of the DTVMI, a group of 142 children between the ages 5 to 12 years was tested in 2010 to measure the tests' test-retest reliability. The overall results showed test-retest coefficients of 0.88 for the Beery VMI, 0.84 for the Visual Perception test and 0.85 for the Motor Coordination test (Beery & Beery, 2004:107).

The inter-scorer reliability of the 6th edition DTVMI was measured by having 2 individuals score the DTVMI and its supplemental tests completed by 100 children. The results showed inter-scorer reliabilities of 0.93 for the VMI test, 0.98 for the Visual Perception test and 0.94 for the Motor Coordination test (Beery & Beery, 2004:108).

Standard errors of measurement (SEM)

The SEMs for the DTVMI have been determined based on the split-half coefficients of the test. Table 7 in the manual shows standard score SEMs for each age group from age 2 to 17 years (Beery & Beery, 2004:106). The standard score SEM for both the Visual Perception and Motor Coordination tests is 6 (Beery & Beery, 2004:106).

Validity

In order to demonstrate validity, a test must show content, concurrent, construct and predictive validity and should control for bias (Beery & Beery, 2004:111). These topics will now be briefly discussed, as shown in the Beery VMI test manual.

The content validity of the DTVMI and both the Visual Perception and Motor Coordination tests was strongly supported. The item analysis done by the Rasch-Wright, Spearman-Brown and Alpha coefficient analyses quantitatively measure the tests' content validity (Beery & Beery, 2004:111).

Concurrent validity shows how the DTVMI and supplemental test results compare to other visual-motor integration tests and results. The DTVMI correlated on a level of 0.75 with the copying subtest of the *Developmental Test of Visual Perception* (DTVP-2) and correlated on a level of 0.52 with the drawing test of the *Wide Range Assessment of Visual Motor Abilities* (WRAVMA). The supplemental tests of the DTVMI were correlated to the DTVP-2 subtests of *Position in Space and Eye-Hand Coordination*. The Visual Perception test of the DTVMI correlated at a level of 0.62 with the DTVP-2 *Position in Space Test*, and the Motor Coordination test from the DTVMI correlated to the DTVP-2 *Eye-Hand Coordination subtest* at a level of 0.65. The DTVMI has also been correlated to an older visual-motor test, namely the Bender-Gestalt. The correlations ranged from 0.29 to 0.93 (Beery & Beery, 2004:111,112). Brown *et al.* (2011:299) found a significant relationship between the content of the DTVMI and another VMI test, the *Full Range Test of Visual Motor Integration* (FRTVMI). There was a very large correlation between the tests, with a Spearman Rho of 0.70 ($p<0.000$).

Construct validity of the DTVMI was measured by identifying 7 constructs and assessing hypotheses relating to these constructs. The 7 constructs were: 1) the results will relate to chronological age; 2) the results from the DTVMI and both supplemental tests will correlate with one another; 3) there should be evidence showing the DTVMI is more taxing than the separate supplemental tests; 4) the DTVMI and supplemental tests should correlate moderately with nonverbal intelligence tests and less so with verbal intelligence tests; 5) the results of the DTVMI should correlate with academic achievement test results; 6) the Rasch-Wright item and person separation indices should be high; and 7) the DTVMI is sensitive to certain disabilities and the results should be lower in these populations. All these constructs are confirmed and supported (Beery & Beery, 2004:113-120).

Predictive validity of the DTVMI is supported by many studies (Beery & Beery, 2004:121) indicating that the DTVMI is a valuable predictor of academic achievement. Pieters *et al.* (2012:501) found that children who had mathematics learning difficulties scored low on the DTVMI ($p<0.001$), which suggests a relationship between VMI skills and mathematics skills. Dunn *et al.* (2006:955) in a South African sample found a significant relationship between the participants DTVMI scores and teachers' ratings of academic skills, such as school readiness, reading, arithmetic, writing, fine motor skills and concentration ($p<0.01$). Sortor and Kulp (2003:760) found a significant difference in DTVMI scores between participants from the upper and lower quartiles of maths and reading skills. Pienaar *et al.* (2013:374) found that children with good VMI scores have a better chance of achieving good academic performance. The predictive ability of the DTVMI seems to decline as children grow older and move from grade to grade (Beery & Beery, 2004:121,122).

Test of gross motor development-2

The Test of Gross Motor Development (TGMD-2) will be performed on an individual basis with each participant. To prevent bias a Kinderkineticist, who is a member of the South African Professional Institute of Kinderkinetics (not the researcher), will perform the test. The TGMD-2 is a standardized test that measures gross motor abilities that develop early in life and is a useful measuring tool for research involving gross motor development (Ulrich, 2000).

Background of the TGMD-2

Ulrich (2000:1) describes gross motor development as an important facet of early childhood that is often overlooked by educators. The preschool years are very important for children because a child's motor abilities start to appear and mature (Ulrich, 2000:1). Ulrich (2000:1) notes that if deficiencies in an individual's motor skills are not remediated timeously he/she may experience lifelong problems with motor skills. The TGMD-2 was developed as an integral part of screening programs for preschool and elementary aged children.

Gross motor skills are defined by Ulrich (2000:1) as:

> *"*Motor skills that involve the large, force-producing muscles of the trunk, arms and legs*"*

Ulrich (2000:1) notes that gross motor skills include movements that involve moving the body from one place to another (locomotion) and movements involving throwing and catching objects like balls (object control). Therefore, the TGMD-2 includes 2 subtests, 1 for locomotion and 1 for object control (Ulrich, 2000:1). It is important to note that Ulrich and the TGMD-2 test emphasises measuring the individual's coordination of their gross motor muscles during the task, rather than the task's ultimate result (Ulrich, 2000:1).

Description of the subtests

The TGMD-2 includes 2 subtests. Various skills are divided into the 2 subtests: Locomotor and Object Control, each subtest measures a specific facet of gross motor development.

Locomotor

The following tasks measure the child's fluidity and coordination of their body as they move from one place to another (Ulrich 2000:3,46-48). The following steps are given in more detail in Appendix D (pp:96):

1. *Run*- advancing steadily using springing steps, with a period of time where both feet leave the ground with each step
2. *Gallop*- the ability to perform a fast, natural 3-beat gait; step forward with the leading foot, followed by a step with the other foot to a position next to or just behind the lead foot
3. *Hop*- hopping on each foot; take off and land 3 times with preferred foot, then take off and land with non-preferred foot
4. *Leap*- the ability to perform a leap over an object; take off on one foot and land on the other with a relatively long period off the ground
5. *Horizontal jump*- the ability to perform a two-footed horizontal jump from a standing position
6. *Slide*- slide in a straight line from one point to another; body is turned sideways, a step with the leading foot followed by a step with the trailing foot

Object Control

The following tasks measure the child's ability to throw, strike and catch various sized balls (Ulrich 2000:3,49-51). A more detailed description of the following steps can be found in Appendix E (pp:99):

1. *Striking a stationary ball*- the ability to strike a stationary ball at his/her belt level with a plastic bat

2. *Stationary dribble*- the ability to dribble a basketball 4 times with the dominant hand before catching the ball with both hands
3. *Catch*- the ability to catch a plastic ball that has been tossed to you
4. *Kick*- the ability to kick a stationary ball with the preferred foot, with a run-up
5. *Overhand throw*- the ability to throw a ball against a wall with the preferred hand
6. *Underhand roll*- the ability to roll a ball between 2 cones with the preferred hand

Administration and Scoring of the TGMD-2

Administration

It is emphasised that although the detailed administration cues and scoring criteria is given on the Examiner Record Form, these are merely a guide and the researcher should be fully prepared for and familiar with the test items (Ulrich, 2000:9).

Scoring

The performance criteria given in the manual and on the Examiner Record Form describe behavioural components of each task that represent the behaviours or actions of the mature performance of the skill (Ulrich, 2000:9). The researcher scores the child on each criterion as follows:

- If the component is performed correctly the researcher scores 1.
- If the component is performed incorrectly or inconsistently the researcher scores 0.

The child performs each task twice, the researcher scores each trial and component as above. The researcher adds up the total score for each task (both trials) and this becomes the raw skill score for the task. The skill scores are then added up to obtain the total raw score for each subtest (Locomotor or Object Control). The raw scores are converted into standard scores using the tables provided in the manual. The standard scores for the Locomotor and Object Control subtests are combined and an overall Gross Motor Quotient (GMQ) is given (Ulrich, 2000:9).

Interpreting the TGMD-2 results

The TGMD-2 produces 4 kinds of scores, namely: raw scores; percentiles; standard scores; and age equivalents.

Raw scores

The raw score is the performance criteria for each task added up. These scores have no clinical value because each task varies in difficulty. The raw scores are used to obtain further scores using normative data provided (Ulrich, 2000:14).

Percentiles

Percentiles or percentile ranks are used to show the percentage of scores that are equal to or below that specific score (Ulrich, 2000:14). If a child receives a percentile rank of 70, this means that 70% of the normative data scores are equal to or below the child's score (Ulrich, 2000:14). Percentile scores for the child's scores for the subtests and the overall composite can be found in the examiners' manual (Ulrich, 2000:54-58).

Subtest Standard Scores

Raw scores are converted into subtest standard scores using the tables provided in the examiner's manual (Ulrich, 2000:54-56). Researchers cannot make interpretations on raw scores alone; researchers must convert scores into the standard scores before comparing the child's performance across each subtest and with other peers. Once the raw scores have been converted to standard scores, researchers can see whether a child scored poorly on one subtest relative to the other subtest (Ulrich, 2000:15).

Gross Motor Quotient

The GMQ is calculated by adding the subtest standard scores and then converting that number into a quotient using the examiner's manual (Ulrich, 2000:58). This GMQ is seen as the most reliable score for the TGMD-2 as this score gives an interpretation of the child's overall motor ability across both subtests (Ulrich, 2000:15).

The norms for TGMD-2 subtest standard scores are given with a mean of 10 and a standard deviation of 3, with the standard score of the composite of the 2 tests with a mean of 100 and a standard deviation of 15 (Ulrich, 2000:28).

Descriptive Ratings

Table 3.3 contains the descriptive categories that are used to describe an individual's score.

TABLE 3.3: **DESCRIPTIVE RATINGS (TGMD-2)**

Subtest Standard score	Gross Motor Quotient	Descriptive Ratings
17-20	>130	**Very Superior**
15-16	121-130	**Superior**
13-14	111-120	**Above Average**
8-12	90-110	**Average**
6-7	80-89	**Below Average**
4-5	70-79	**Poor**
1-3	<70	**Very Poor**

Source: Adapted from Ulrich, (2000:15)

Age Equivalents

Age equivalents are calculated by converting the child's raw scores into age equivalent scores in the examiners manual (Ulrich, 2000:60). This age equivalent score gives the researcher an idea as to how the child's performance relates to his age. An age equivalent score of 5:6 means the child performed at the level of a 5 year, 6 month old child. The use of age equivalents is contested, and Ulrich (2000:15,28) advises caution when using the age equivalent score.

Reliability of the TGMD-2

The reliability of the TGMD-2 has been measured using the entire normative sample. The reliability of the TGMD-2 has been calculated with regards to 3 sources of error: content sampling (internal consistency); time sampling; and inter-scorer differences (Ulrich, 2000:29).

The overall reliability of the TGMD-2 is tabulated below in Table 3.4 as given by the author in the examiner's manual (Ulrich, 2000:33).

TABLE 3.4: **OVERALL RELIABILITY OF THE TGMD-2**

	Source of Test Error		
TGMD-2 Scores	**Content Sampling**	**Time Sampling**	**Inter-Scorer**
Locomotor Subtest	0.85	0.88	0.98
Object Control Subtest	0.88	0.93	0.98
Gross Motor Quotient	0.91	0.96	0.98

Source: Adapted from Ulrich (2000:33)

Validity of the TGMD-2

As described by Ulrich (2000:35) in simple terms, validity of a test refers to the test's ability to do what it is meant to do, or measure what it is meant to measure. Three main types of validity have been described by Ulrich (2000:35): content-description validity; criterion-prediction validity; and construct-identification validity.

Content-description validity shows whether the selection of the items that make up the test measure the behaviour domain specified (Ulrich, 2000:35). Ulrich (2000:36) discussed the test items with professionals knowledgeable in gross motor development of young children, and all agreed that the test content measured gross motor skills of elementary aged children. The test content was conventionally analysed using the item-total-score Pearson correlation and it was found that all items in the TGMD-2 were identified as "good" items (Ulrich, 2000:36).

The criterion-prediction validity refers to whether the test in question can accurately predict an individual's performance in a specific domain; to find this the test is measured against another test that examines the same domain (Ulrich, 2000:37). The TGMD-2 was assessed against the Basic Motor Generalizations subtest of the *Comprehensive Scales of Student Abilities (CSSA)*. Both tests were administered on a sample of 41 children, and a correlation of 0.63 for Locomotor and 0.41 for Object Control was found (Ulrich, 2000:37). This shows a moderate to strong correlation, leading to the TGMD-2 being valid in terms of criterion-prediction. The TGMD-2 was also compared to the Movement

Assessment Battery for Children (MABC-2) and significant correlations were found for the overall performance in the TGMD-2 and the MABC-2, as well as specifically for the object control and aiming and catching subtests of the two tests (Logan *et al.*, 2011:720).

For construct-identification validity, 5 constructs were identified and measured to determine the overall support or non-support of construct-identification validity. The 5 constructs tested were: 1) performance on the TGMD-2 must correlate with chronological age; 2) the results of the TGMD-2 should differentiate between groups of individuals that score on, above, or below average; 3) the items of each subtest must correlate to the total score for that subtest; 4) because the subtest of the TGMD-2 assess gross motor development albeit in different ways, the subtest results must correlate moderately with each other; and 5) a factor-analysis of the subtest skills was done to measure the relationship of the skills to the models' inherent constructs (Ulrich, 2000:37). In all 5 constructs the construct-identification validity was tested and supported (Ulrich, 2000:37-40).

The following section provides a description of the intervention programme used during the current study. The complete intervention programme can be found in Appendix F (pp:101)

Intervention

An intervention of 14 weeks followed the pre-test. The intervention sessions were performed twice a week for the allotted 14 weeks, each session lasted 45 minutes, with actual activity-time being 30 minutes. The sessions were implemented within a small group setting. The experimental group consisted of 12 participants across the two Grade R classes; this group of 12 was divided into two groups of six participants from each class, in order to minimize the influence that different teachers might have on the results.

A group setting was used to emphasise that this type of intervention can easily be used in schools on a regular basis with the whole class.

The gross motor intervention focused first and foremost on VMI. Visual-motor integration activities include target games, where various objects must be thrown, kicked or rolled to a specific target, either on the floor, in the air, or to a person who catches the object. Catching is also included as a VMI skill. Visual perception skills (perceiving picture differences) and motor coordination (threading beads onto a lace, connecting dots on pictures) was practiced separately as well.

The following specified underlying factors relating to VMI and academic skills were also the focus of the gross motor intervention: laterality; directionality; upper body strength and coordination; motor planning and coordination; and proprioception. These have been discussed in Chapter two.

Imitation exercises along with VMI, visual perception, and the above-mentioned underlying relating factors were practiced in a 2D format with pen-and-paper activities and drawings. Activities were repeated where necessary, until complete understanding and precision was reached by the participants.

Post-test

After the 14-week intervention programme the post-test was performed on the experimental and control groups.

The DTVMI and its supplemental tests on Visual Perception and Motor Coordination, and the TGMD-2, as explained above, were re-administered on the participants. The testing was administered by the same Occupational Therapist and the same Kinderkineticist, with the researcher.

The results of the pre- and post-tests were statistically compared and analysed to find whether the self-designed gross motor intervention programme was successful in improving the experimental group’s VMI and gross motor skills.

In the following chapter the results will be discussed in detail.

CHAPTER FOUR

RESULTS AND DISCUSSION

INTRODUCTION

Visual-motor integration (VMI) can be defined as the coordination of visual perception skills and motor skills (Kulp & Sortor, 2003:312). Visual-motor integration skills help a child to copy a figure onto a page, using visual perception skills to perceive the figure, and motor coordination skills to reproduce the figure by pencil on paper. Researchers discuss the need to emphasise the focus on the *integration* of visual perception and motor coordination, not solely on one or the other (Kulp & Sortor, 2003:313; Pieters *et al.,* 2012:498).

Visual-motor integration (VMI) has been discussed as a predictor of academic performance (Beery & Beery, 2004:121). Academic skills like reading and writing require VMI skills (Feder & Majnemer, 2007:313). Success in school depends on whether a child can perform reading and writing skills optimally (Dankert *et al*., 2003:543).

Underlying gross motor factors that influence performance in academic skills like reading and writing have been discussed in the literature (Dankert *et al*., 2003:542; Feder & Majnemer, 2007:313; Van der Merwe *et al.*, 2011:4; Van Jaarsveld *et al.*, 2011:6), therefore, the current study researched the effects of a gross motor intervention programme on VMI skills of children. In the current study, researching the effects of a gross motor intervention programme on VMI skills, participants from two schools were tested to determine their visual-motor integration skills, using the Beery-Buktenica Developmental Test of Visual Motor Integration 6th Edition (DTVMI) (Beery & Beery, 2004). Children that received a score of below average on the DTVMI continued in the study. The final group of participants were then tested using the Test of Gross Motor Development (TGMD-2) (Ulrich, 2000). The group was divided into an experimental and a control group.

The experimental group took part in a 14-week intervention programme consisting of two sessions per week with a duration of 30 minutes each. The control group sat in their classroom with their teacher and listened to children's stories on a CD during this time.

The experimental and control groups were then tested again post-intervention using the same tests as in the pre-test. Their results were recorded and compared in this chapter. The results reported in this chapter pertain to the specific aims and objectives underlined in the current study.

Specific Aims:

1. To determine the VMI skill level of the selected preschool children.
2. To determine whether there were differences in VMI skills between preschool boys and girls.
3. To determine whether a self-designed gross motor intervention programme can improve the VMI skills.

DEMOGRAPHIC PROFILING

All participants were between the age of 5 and 6 years. Of the total group there were more boys (N=43) than girls (N=34). Birth dates and gender were provided by the schools within the Centralised Educational Information System (CEMIS) class lists. Participants were tested to determine their VMI skill level. The participants who scored below a pre-determined score continued to participate in the study (N=23). This final group was then divided into an experimental group (n=12) and a control group (n=11).

The data collected pertaining to the specific aims of the current study will be presented with the use of graphs and tables and will be discussed with reference to previous research in the following sections.

All results were analysed with a 5% significance level ($p<0.05$) as a guideline for significance.

SCHOOLS

The VMI pre-test scores for the participants from the two socio-economic schools were compared. Participants from the low socio-economic school (School W) scored significantly lower than participants from the higher socio-economic school (School B) ($p=0.0013$).

School W scored a mean of 86.22 (±13.19) standard score points on the VMI, while School B scored a mean of 99.35 (±8.64) standard score points, which indicated a statistically significant difference of 13.13 points between the mean scores of the two schools ($p=0.0013$). In Figure 4.1 it can be seen that School B scored considerably higher in VMI skills than School W. This result mirrors previous studies with regards to VMI skills and SES.

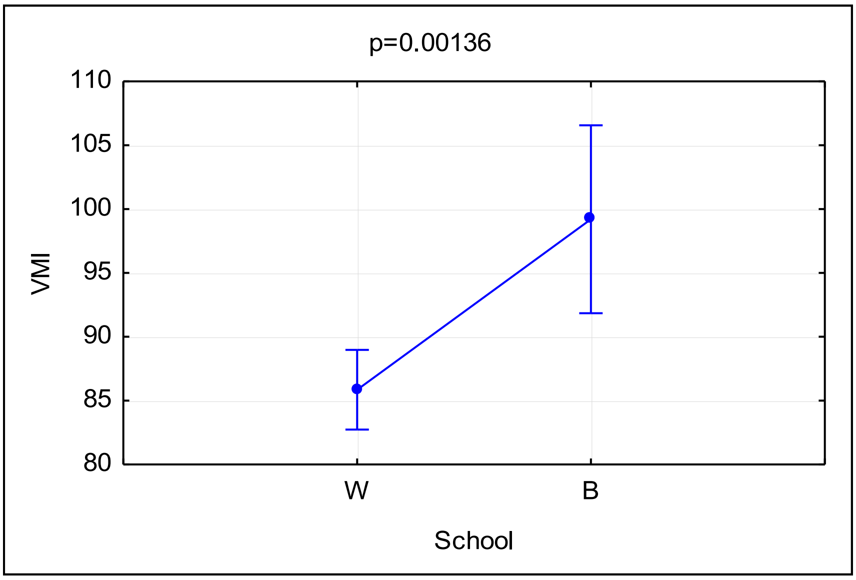

FIGURE 4.1: **VMI SKILLS BETWEEN SCHOOL W AND SCHOOL B**

In another South African based study, Dunn *et al*. (2006:955) found significant differences between socio-economic groups when testing a multi-ethnic preschool sample of 238 children using the DTVMI ($p<0.01$). Singh and Franzsen (2011:42) tested 50 South African children aged between six and ten years, living in various housing institutions and found that children from the lower socio-economic institutions and backgrounds scored significantly lower in VMI skills than those who were in the middle socio-economic group ($p<0.05$). Similarly, but not entirely significantly, Lotz *et al.* (2005:65) tested 339 children between Grades 1 and 4 and reported that children of lower SES had a markedly lower VMI skill level than children of higher SES ($p=0.13$).

Many studies of the subject have shown that having lower socio-economic status is consistent with lower scores on developmental and educational standardized tests. In a study of Brazilian children aged 7 to 12 years from various socio-economic background, it was found that children from the lower SES scored significantly lower than those from higher SES in visual discrimination and VMI tests ($p=0.001$) (Frey & Pinelli, 1991:848). Bowman and Wallace (1990:614) also found that preschool children in the higher SES groups of participants scored substantially higher than their lower socio-economic counterparts on the Beery DTVMI ($p=0.000$).

GENDER

With regards to gender, no significant difference was found (p=0.31) in the performance between boys and girls in VMI skills. Girls scored a mean of 90.91 (±12.89) standard score points in VMI skills, while boys scored a mean of 88.62 (±13.91). This difference of 1.99 points between the mean scores is very slight, and not statistically significant (p=0.31).

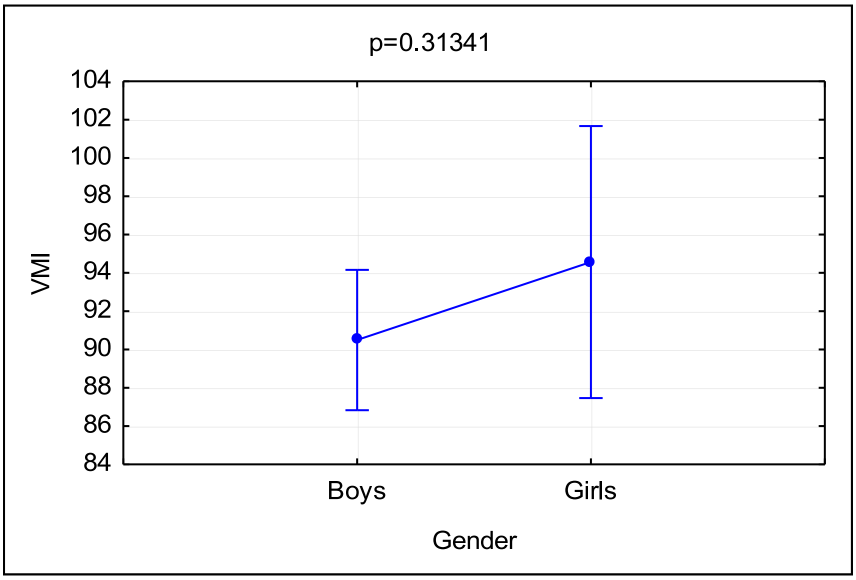

FIGURE 4.2: **VMI SKILLS BETWEEN BOYS AND GIRLS**

Mirroring the current study's results, Soderman *et al.* (1999:13) found that girls (n=439) in first grade scored higher than boys (n=483) on the DTVMI, but the difference between the gender groups was not statistically significant (p=0.054). The current findings oppose previous South African research on the topic. Lotz *et al.* (2005:65) who found that boys in Grades 1 through 4 scored significantly higher than girls in the VMI test (N=339) (p=0.001). However, in the research performed by Emam and Kazem (2013:552) in a non-South African sample, they also found no significant difference between boys' and girls' VMI scores. In a Canadian sample of 151 kindergarten children (aged five to six years), it was found that girls scored significantly higher than boys when tested on VMI skills (Coallier *et al.*, 2014:4). Duiser *et al.* (2013:79) found that more boys in Grade 2 were classified as having writing problems than girls (p<0.001), and that when tested using the DTVMI, girls scored significantly higher in the motor coordination supplementary test (N=240) (p<0.05).

Gender differences with regards to gross motor skills were not measured in the current study due to the small amount of girls in the experimental group, which would lead to effect sizes being too small to make any worthwhile statistical deductions.

VISUAL MOTOR INTEGRATION

Response to intervention

It was found that there was no significant difference between the experimental group and control groups' response to the intervention period, as both groups improved equally well from pre- to post-test (p=0.52). The experimental group improved more than the control group, but not statistically significantly.

Table 4.1 below shows the VMI mean scores with standard deviations, from pre- to post-test for the experimental and control groups. The difference between the groups at pre-test was small; 0.25 standard score points. The difference between the experimental and control group at post-test was relatively larger with the experimental group scoring 2.77 standard score points higher than the control group. Both the experimental and control groups increased their scores from pre- to post-test, by 16.33 and 13.81 standard score points respectively. The difference over time for the experimental and control groups is depicted in Figure 4.3. The experimental group improved by an average of 2.52 points over the control group on their VMI scores. This suggests that the intervention programme had some positive effect on the experimental group; this is, however, insignificant statistically.

TABLE 41: **VMI SCORE MEANS, STANDARD DEVIATIONS AND DIFFERENCES BETWEEN PRE- AND POST-TEST FOR EXPERIMENTAL AND CONTROL GROUPS**

Group	PRE TEST: Mean ± SD	POST TEST: Mean ±SD	Mean differences within groups (pre-post)
Experimental	76.16 ± 10.28	92.50 ± 8.74	-16.33
Control	75.90 ± 6.17	89.72 ± 10.37	-13.81
p +	-0.25	-2.77	

p+ : Difference between groups in pre- and post-tests

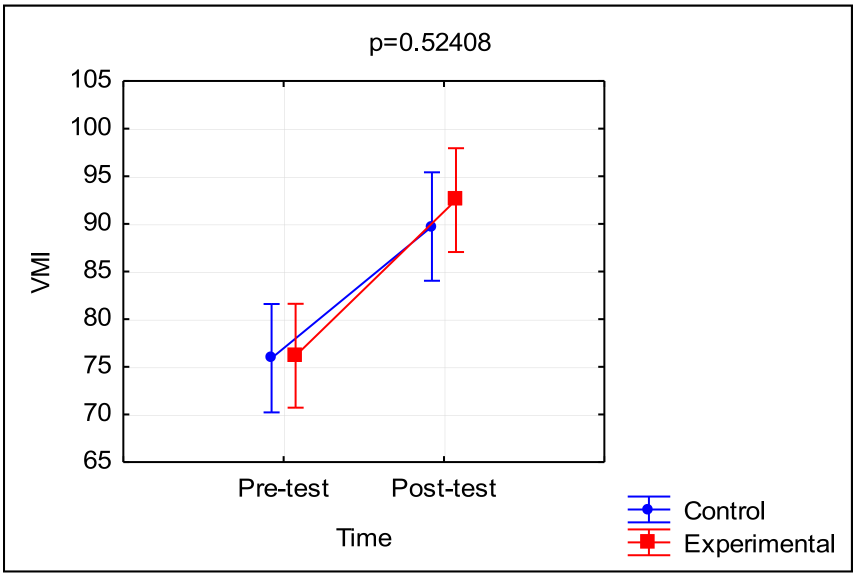

FIGURE 4.3: **DIFFERENCE OVER TIME BETWEEN THE EXPERIMENTAL AND CONTROL GROUPS**

Discussion of VMI results

No exact replicas of this study have been found. Most studies that measure the effect of an intervention focus on occupational therapy, fine motor and handwriting activities and not gross motor activities (Dankert *et al.*, 2003:542; Poon *et al.*, 2010:1554; Vinter & Chartrel, 2010:479; Van der Merwe *et al.*, 2011:3; Van Jaarsveld *et al.*, 2011:5; Dibek, 2012:1924; Ohl *et al.*, 2013:507).

Dibek (2012:1927) found that an intervention programme for 5 year old children (N=33) using 2D reading materials and 3D models and board games, and pen to paper exercises, had a positive effect on the experimental group in VMI, visual perception and motor coordination ($p<0.00$). Dankert *et al.* (2003:546) also found that their experimental group of preschool children with developmental delays (N=12) showed a significant improvement in VMI skills after an occupational therapy intervention ($p<0.0005$). Vinter and Chartrel (2010:479) investigated the effect of different types of handwriting training on handwriting performance of preschool children (N=48). It was found that visual-motor training was the most effective in improving the participants' handwriting (Vinter & Chartrel, 2010:484). Ohl *et al.* (2013:507) investigated the effects of an intervention programme on the visual-motor and fine-motor abilities of kindergarten participants (N=113). It was found that intervention participants significantly improved VMI skills scores ($p=0.009$) and fine motor skills scores ($p=0.023$), from pre- to post-intervention, while control participants' scores slightly decreased in these skills (Ohl *et al.,* 2013:511). Poon *et al.* (2010:1558) found that their intervention programme of computerized games had no effect on the VMI skills of participants in Grade 1 (N=26).

VISUAL PERCEPTION AND MOTOR COORDINATION SUPPLEMENTAL TESTS

Visual perception

The experimental and control groups' improvements over the intervention period was the same (p=0.86).

Both groups improved over the 14-week period, with the experimental group improving more, but not significantly so. Table 4.4 provides a summary of the results for visual perception test of both groups:

TABLE 4.2: **VISUAL PERCEPTION MEAN SCORES, STANDARD DEVIATIONS AND MEAN DIFFERENCES OVER TIME IN EXPERIMENTAL AND CONTROL GROUPS**

Group	PRE TEST: Mean ± SD	POST TEST: Mean ± SD	Mean differences within groups (pre-post)
Experimental	79.50 ± 12.33	88.08 ± 12.65	-8.58
Control	78.09 ± 14.34	85.54 ± 13.47	-7.45
p +	-1.40	-2.53	

p+ : Difference between groups in pre- and post-tests

Pre-test the experimental and control groups differed by 1.40 points. Post-test the difference between the groups increased to a difference of 2.53 standard score points. The experimental group improved by 8.58 standard score points in visual perception skills, which is slightly more than the control group (7.45). This suggests that the intervention may have helped improve visual perception skills albeit only on a small scale. Figure 4.4 presents the differences between the experimental and control groups before and after the intervention programme.

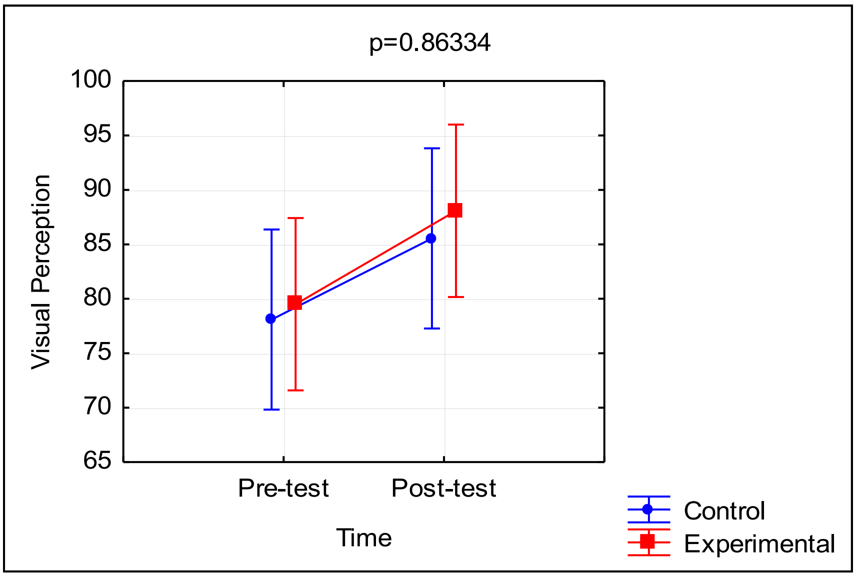

FIGURE 4.4: **DIFFERENCES IN VISUAL PERCEPTION SCORES FROM PRE TO POST TEST IN EXPERIMENTAL AND CONTROL GROUPS**

Motor coordination

The second supplemental test performed on the sample was the test for motor coordination skills. The interaction found showed that both the experimental and control groups improved the same amount from pre- to post-test (p=0.27).

The experimental group scored marginally lower at post-test than at pre-test, while the control group improved after the 14-week period. This improvement and difference was, as mentioned, not significant.

The differences within this sample are summarised in Table 4.5. The experimental group's slight decline by 0.25 standard score points is marginal. The control group improved by 4.72 standard score points over the 14 week period.

TABLE 4.3: **MOTOR COORDINATION MEANS, STANDARD DEVIATIONS AND MEAN DIFFERENCES OVER TIME FOR EXPERIMENTAL AND CONTROL GROUPS**

Group	PRE TEST: Mean ± SD	POST TEST: Mean ± SD	Mean differences within groups (pre-post)
Experimental	99.50 ± 12.19	99.25 ± 14.34	0.25
Control	97.90 ± 7.24	102.63 ± 6.42	-4.72
p +	-1.59	3.38	

p+ : Difference between groups in pre- and post-tests

Figure 4.5 compares the experimental and control group and their change from pre- to post-test in motor coordination scores.

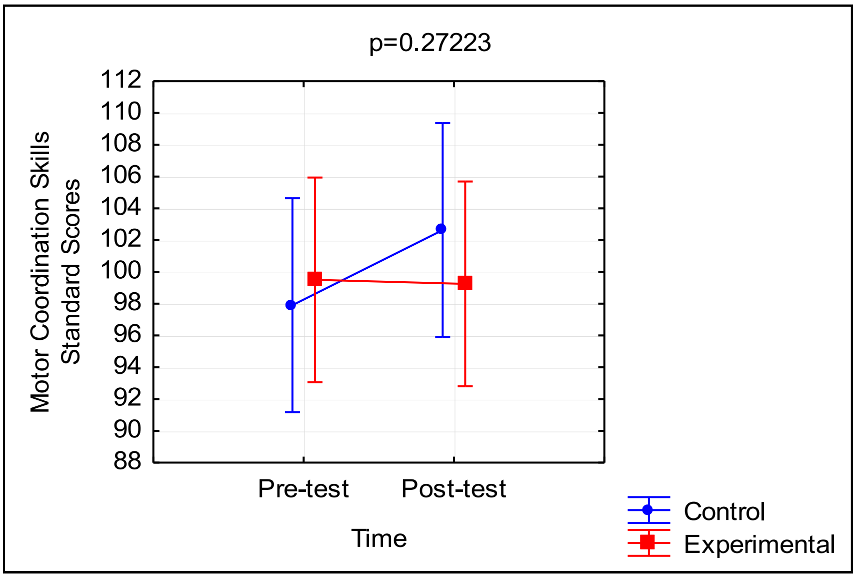

FIGURE 4.5: **DIFFERENCES IN MOTOR COORDINATION SCORES FROM PRE TO POST TEST IN EXPERIMENTAL AND CONTROL GROUPS**

Discussion of visual perception and motor coordination results

Studies using the DTVMI tend to include the supplemental tests of visual perception and motor coordination in the testing procedures. It is reported that difficulties in VMI can be due to one of three deficits, namely in; problems with perceiving visual stimuli, the ability to perform a coordinated motor response to the stimuli, or an integration of these two afore-mentioned skills (Sortor & Kulp, 2003:758; Pieters *et al*., 2012:498). Testing participants using all three tests (VMI, VP and MC), allows the researcher to understand in *which* skill the participant has the deficit.

This particular sample in the current study scored lower in visual perception skills (78.79 ± 13.04) than in motor coordination skills (98.73 ± 9.94) at pre-test. Therefore, it can be said that the group generally had a more notable visual perception deficit and not a motor coordination problem.

Vinter and Chartrel (2010:479) studied the effect of purely visual training on handwriting performance of five-year-old children (N=48). Vinter and Chartrel (2010:485) also found improvements in handwriting with motor training; however, the positive effect of motor training was slighter than that of visual training. Poon *et al*. (2010:1553,1556) investigated the effect of a computer games intervention programme on the visual perception skills of Grade 1 learners (N=26), and found that visual perception skills were improved through the intervention programme (p=0.012). Dankert *et al.* (2003:546), as discussed before, showed the effects of an occupational therapy intervention programme on preschool children (N=43), and found a significant improvement in visual perception skills (p<0.005), but no significant improvement with motor coordination skills (p=0.001). Dibek (2012:1927) found significant increases in VMI skills of five-year-olds (N=33), and reported significant increases in both motor coordination skills and visual perception skills (p<0.000).

GROSS MOTOR SKILLS: TGMD

Secondary to the VMI skills testing, the participants' gross motor skills were tested before and after the intervention period to measure the effect of the intervention on gross motor skills. The Test of Gross Motor Development 2nd Edition was used (Ulrich, 2000). The TGMD-2 is divided into three major scores; the Gross Motor Quotient (GMQ), Locomotor and Object Control (Ulrich, 2000:3). The GMQ is found by adding the two subtest scores from the Locomotor skills test and the Object control skills test. The GMQ is the most reliable definition of the participant's overall current gross motor development (Ulrich, 2000:15,16). The Locomotor subtest measures the participant's ability to move fluidly from one point to another in various ways, while the Object control subtest measures the participant's ability to project and receive various objects (Ulrich, 2000:3,16).

Response to intervention

Both experimental and control groups improved their total gross motor skills scores over the intervention time. There was no difference in the amount of improvement of the two groups;

they improved the same amount from pre- to post-test (p=0.58). Table 4.6 highlights the mean differences between the two groups.

Pre-test, the experimental group scored an average of 115.50 (± 16.07) and the control group scored an average of 110.63 (± 10.33) standard score points. The difference between the experimental and control group at pre-test was 4.86 standard score points, and at post-test the difference increased and the groups differed by 7.22 points, with the experimental group still scoring higher. The experimental group improved by 7 standard score points over the intervention period, showing slightly more improvement than the control group (4.63 standard score points).

TABLE 4.4: **TOTAL GROSS MOTOR SKILLS MEAN DIFFERENCES, STANDARD DEVIATIONS AND MEAN DIFFERENCES OVER TIME FOR EXPERIMENTAL AND CONTROL GROUPS**

Group	PRE TEST: Mean ± SD	POST TEST: Mean ± SD	Mean differences within groups (pre-post)
Experimental	115.50 ± 16.07	122.50 ± 11.47	-7.00
Control	110.63 ± 10.33	115.27 ± 8.31	-4.63
p +	-4.86	-7.22	

p+ : Difference between groups in pre- and post-tests

Figure 4.6 represents the results found with regards to gross motor skills.

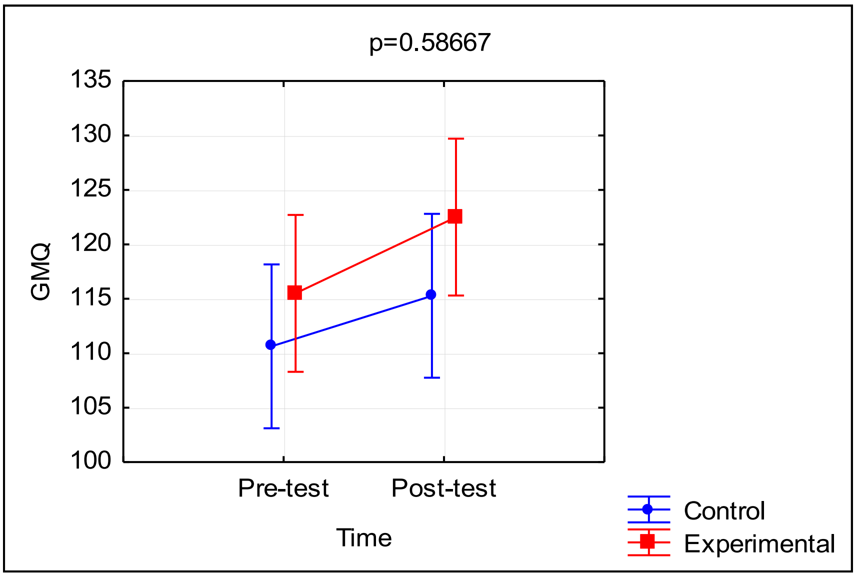

FIGURE 4.6: **DIFFERENCES OVER TIME IN GROSS MOTOR SKILLS IN THE EXPERIMENTAL AND CONTROL GROUPS**

Table 4.7 shows the number of experimental group participants within each descriptive category as given by Ulrich (2000:15) for both pre- and post-test gross motor quotient scores. It can be seen that all scored in the average category or above. This shows that none of the participants had a delay in overall gross motor skills. Post-test it can be seen that the experimental group participants increased in "very superior" scores and "superior" scores, and decreased in "average" scores. This shows that the participants improved their GMQ scores.

TABLE 4.5: **DESCRIPTIVE RATINGS OF THE EXPERIMENTAL GROUP'S GMQ SCORES AT PRE- AND POST-TEST**

Category	**Pre-Intervention (n)**	**Post-Intervention (n)**
Very Superior (>130)	3	4
Superior (121-130)	2	4
Above average (111-120)	2	2
Average (90-110)	5	2
Below average (80-89)	0	0
Poor (70-79)	0	0

Very Poor (<70)	0	0

Discussion of overall gross motor skills

Gursel (2014:308) conducted a gross motor intervention programme on preschool children with hearing impairment (n=7) and children with normal hearing (n=11). Gursel (2014:311,312) found that both groups (hearing-impaired and normal hearing) improved from pre- to post-test They found a statistically significant change in their overall locomotor skills (p=0.01 for both groups) and for overall object control skills (p=0.001 for hearing impaired and p=0.01 for normal hearing). It is interesting to note that at pre-test all the participants, both hearing and hearing-impaired, had developmental delay at or below the 25th percentile norms (Gursel, 2014:310).

Goodway and Branta (2003:36) studied the effects of a gross motor intervention programme on the fundamental motor skills of their preschool sample (N=59). They found the experimental group improved significantly more than the control group over time, in both locomotor skills and object control skills (p<0.001). Apache (2005:1012) studied the effect of different types of physical education programme instruction on motor skill performance of pre-schoolers (N=28) with developmental delays, namely activity-based instruction and direct instruction. It was found that an activity-based programme, which is directed more by the children with the teacher as a mere facilitator to the lesson, was most effective in improving children motor skills (Apache, 2005:1019). Kordi *et al.* (2012:357) studied the effectiveness of a gross motor skills programme in nursery school children aged between three and six years old (N=147). It was found that the participants significantly improved their overall gross motor quotient scores from pre- to post-test (p<0.001). Bellows *et al.* (2013:28) investigated the effect of a gross motor intervention programme on three to five-year-old participants and found that the experimental group (n=98) improved significantly in GMQ scores compared to the control group (n=103) (p=0.006). Zask *et al*. (2012:10) conducted a gross motor intervention programme in selected preschools throughout the year; a total of 560 children participated in the study. It was found that children from experimental preschools showed a significantly higher increase in fundamental movement scores than the control preschools (p<0.001).

Draper *et al.* (2012:145) having carried out an intervention programme on a sample of 118 low SES children found that the experimental group who were exposed to the intervention showed significantly better scores in locomotor skills (p<0.05) and object control (p<0.01). In a 12-month intervention study also investigating low SES children (N=460), Cohen *et al.* (2014:n.p) found that the intervention group scored significantly higher than participants in the control group in overall fundamental motor skills.

LOCOMOTOR SKILLS AND OBJECT CONTROL SKILLS

Locomotor skills

There was no significant difference between the experimental and control groups' response to the intervention period; both groups improved the same from pre- to post-test (p=0.55).

The results found for the locomotor subtest are summarised in Table 4.8. The experimental group scored a mean of 12.75 (±3.74) standard score points, while the control group scored a mean standard score of 11.90 (±2.62). The difference of 0.84 at pre-test was small and was found to be statistically insignificant (p=0.49). At post-test, the difference between the groups increased to 1.64 standard score points. The experimental group improved over the intervention period by a mean of 1.16 points, which is more than the control group's improvement of a mean of 0.36 points. This could be attributed to the fact that the experimental group participated in the intervention activities.

TABLE 4.6: **LOCOMOTOR SKILLS MEANS, STANDARD DEVIATIONS AND MEAN DIFFERENCES OVER TIME FOR EXPERIMENTAL AND CONTROL GROUPS**

Group	PRE TEST: Mean ± SD	POST TEST: Mean ± SD	Mean differences within groups (pre-post)
Experimental	12.75 ± 3.74	13.91 ± 2.93	-1.16
Control	11.90 ± 2.62	12.27 ± 2.00	-0.36
p +	-0.84	-1.64	

p+ : Difference between groups in pre- and post-tests

Figure 4.7 shows the experimental group improved more than the control group over the intervention period.

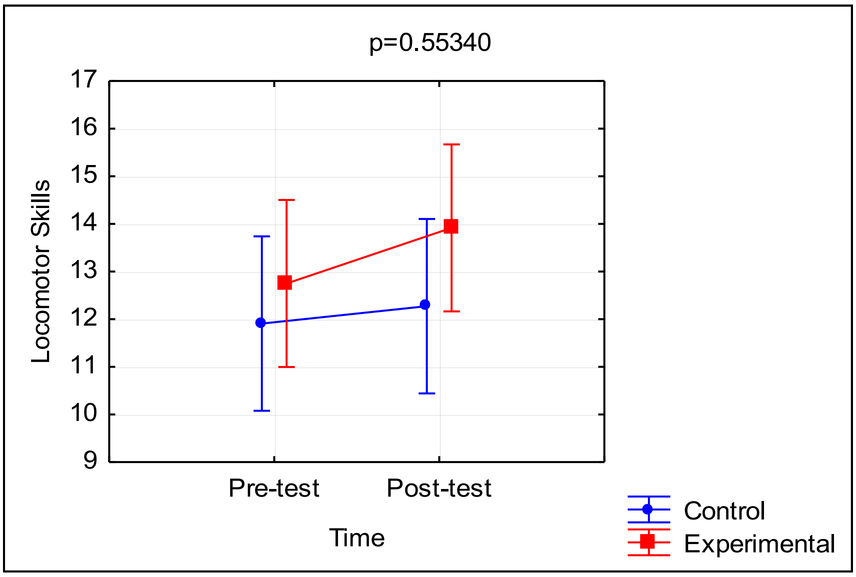

FIGURE 4.7: **DIFFERENCE OVER TIME IN LOCOMOTOR SKILLS IN THE EXPERIMENTAL AND CONTROL GROUP**

Table 4.9 shows the number of experimental participants in each descriptive category for the locomotor subtest scores. It can be seen that all the experimental participants scored in the "average" category or above at pre-test. It can be seen that the number of experimental participants within the "above average" and "superior" categories increased, while the number of experimental participants within the "average" category decreased. It can be noted that no participants showed any developmental delay in locomotor skills, and this may have left little room for improvement of their scores through an intervention programme.

TABLE 4.7: **DESCRIPTIVE RATINGS OF THE EXPERIMENTAL GROUP'S LOCOMOTOR SKILLS AT PRE- AND POST-TEST**

Category	**Pre-Intervention (n)**	**Post-Intervention (n)**
Very Superior (17-20)	3	3
Superior (15-16)	2	3
Above average (13-14)	0	2
Average (8-12)	7	4
Below average (6-7)	0	0
Poor (4-5)	0	0

Very Poor (1-3)	0	0

Object control skills

With regards to object control, the results showed there was no significant difference between the experimental group and control group in their response to the intervention period; both groups improved pre- to post-test. The two groups improved at the same rate (p=0.98).

Table 4.10 reports the results found. The experimental group scored on average higher than the control group at pre-test with regards to object control skills. The experimental group scored an average of 12.41 (±2.60) and the control group scored an average of 11.63 (±1.56) standard score points. Both the experimental and control groups improved significantly over the intervention period (p=0.042 and p=0.048 respectively), with the experimental group improving by an average of 1.16 points and the control group by an average of 1.18 points. This shows that the intervention did not account for the improvements in object control skills within the experimental group.

TABLE 4.8: **OBJECT CONTROL MEANS, STANDARD DEVIATIONS AND DIFFERENCES OVER TIME WITHIN THE EXPERIMENTAL AND CONTROL GROUPS**

Group	PRE TEST: Mean ± SD	POST TEST: Mean ± SD	Mean differences within groups (pre-post)
Experimental	12.41 ± 2.60	13.58 ± 1.92	-1.16
Control	11.63 ± 1.56	12.81 ± 1.47	-1.18
p +	-0.78	-0.76	

p+ : Difference between groups in pre- and post-test

Figure 4.8 presents the improvement of both groups from pre- to post-test.

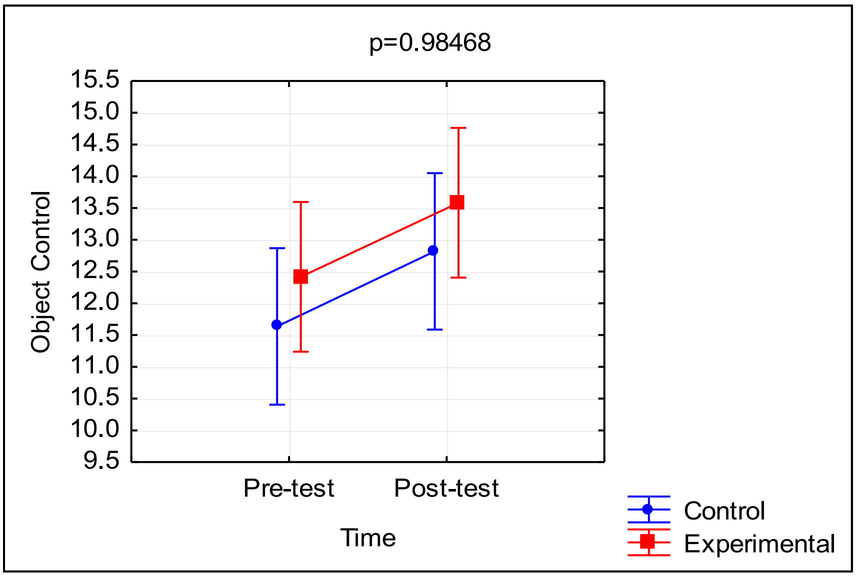

FIGURE 4.8: **DIFFERENCE OVER TIME IN OBJECT CONTROL SKILLS BETWEEN THE EXPERIMENTAL AND CONTROL GROUP**

Table 4.11 shows the number of experimental group participants who scored within each descriptive category for pre- and post-test scores. It can be seen that the experimental group scored generally high for object control skills at pre-test, with all the experimental group participants scoring in the "average" category and above. None of the experimental participants showed below average or poor object control skills. At post-test the number of experimental participants in the "superior" category increased, as well as the "above average" category. The number of participants in the "average" category decreased after the intervention programme.

TABLE 4.9: **DESCRIPTIVE RATINGS OF THE EXPERIMENTAL GROUP'S OBJECT CONTROL SKILLS AT PRE- AND POST-TEST**

Category	**Pre-Intervention (n)**	**Post-Intervention (n)**
Very Superior (17-20)	0	1
Superior (15-16)	3	3
Above average (13-14)	3	5
Average (8-12)	6	3
Below average (6-7)	0	0

Poor (4-5)	0	0
Very Poor (1-3)	00	0

Discussion of locomotor skills and object control skills results

Deli *et al.* (2006:14,15) found dissimilar results in their study of a sample of kindergarten children (N=75). They found that their experimental group improved significantly in locomotor skills after performing the intervention programme; specifically in running (p<0.05), hopping (p<0.01), leaping (p<0.001), horizontal jump (p<0.05) and skipping (p<0.001), while the control group showed no significant differences in any of the locomotor skills (p>0.05) (Deli *et al.*, 2006:14-15). Tsapakidou *et al.* (2014:2) investigated the effects of a primarily locomotor intervention programme on children aged between three-and-a-half and five years (N=98). It was found that the locomotor intervention was effective in significantly improving the locomotor skills of the experimental group (p=0.000) (Tsapakidou *et al.*, 2014:3).

Bardid *et al*. (2013:4575) found that an experimental group of preschool children (n=47) improved their locomotor skills significantly over the intervention period (p=<0.001), but showed no significant improvement in the object control skills over time (p=0.09). Contrary to the current study it was found that the control group (n=46) decreased in object control skills over the intervention period (p<0.001) (Bardid *et al*., 2013:4575). Logan *et al.* (2013:5) investigated the effects of different intervention types (high-autonomy child-centred and low-autonomy teacher-centred), on preschool children's object control skills (N=25). Logan *et al.* (2013:8) found that both types of interventions resulted in an improvement of object control skills of all the children (p<0.001).

SUMMARY OF RESULTS

VMI skills and socio-economic status

The most relevant result found in the current study is the data found regarding the relationship between SES and VMI skills. The VMI pre-test scores for the participants from the two socio-economic areas were compared. Participants from the low socio-economic school (School W) scored significantly lower than participants from the higher socio-economic school (School B) (p= 0.0013).

This result mirrors previous studies with regard to VMI skills and SES (Bowman & Wallace, 1990:614; Frey & Pinelli, 1991:848; Lotz *et al*., 2005:65; Dunn *et al*., 2006:955; Singh & Franzsen, 2011:42).

VMI skills and gender

With regard to gender, no significant difference was found (p=0.31) in the performance in VMI skills between boys and girls.

Some research found results opposing the current study (Lotz *et al.*, 2005:65; Duiser *et al.,* 2013:79; Coallier *et al.*, 2014:4), while other research results mirrored the current study's findings (Soderman *et al*., 1999:13; Emam & Kazem 2013:552).

VMI skills and response to intervention

It was found that there was no significant difference between the experimental group and control groups' response to the intervention period in terms of VMI skills; the experimental group improved more than the control group, but not significantly (p=0.52)

The experimental group improved on average 2.52 points more than the control group on their VMI scores. This suggests that the intervention programme had some positive effect on the experimental group's VMI skills; however, this is insignificant statistically.

Interventional studies for VMI skills that found significant improvements in VMI skills in their participants primarily focused on specific fine motor skills relating to VMI (Dankert *et al.*, 2003:542; Poon *et al*., 2010:1554; Vinter & Chartrel, 2010:479; Van der Merwe *et al*., 2011:3; Van Jaarsveld *et al*., 2011:5; Dibek, 2012:1924; Ohl *et al*., 2013:507). No studies were found that replicated the current study's use of a gross motor intervention programme when attempting to improve VMI skills. Studies found used occupational therapy programmes.

Overall gross motor skills and response to intervention

Both experimental and control groups improved their total gross motor skills scores over the intervention period. The groups improved the same amount from pre- to post-test (p=0.58).

The difference between the experimental and control groups at pre-test was 4.86 standard score points, at post-test the difference increased and the groups differed by 7.22 points, with the experimental group scoring higher. The experimental group improved by 7 standard score points during the intervention period, showing a slight improvement over the control group (4.63 standard score points).

It is important to note that the entire sample tested with the TGMD-2 scored relatively high gross motor quotient (GMQ) scores, while only one participant scored below the 25^{th} percentile, and seven scored at or above the 95^{th} percentile.

Chapter Five will discuss conclusions and recommendations for future studies.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

INTRODUCTION

The current study outlined three specific aims that were investigated thoroughly. These three aims referred to: the VMI skills of preschool children from different preschools; the difference of VMI skills between the genders when comparing VMI skills; and the effect of a gross motor intervention on VMI skills of the sample.

After referring to the data collected and comparing results of the current study with other research some conclusions can now be discussed. Recommendations will be presented for future studies on this topic, and the limitations of the current study will be outlined.

HYPOTHESIS

The hypothesis of the current study theorized that the visual-motor integration skills of the experimental group would be improved through the gross motor intervention programme. The current hypothesis was not supported by the results. No statistically significant improvement was found in VMI skills of the sample after the gross motor intervention programme.

SOCIO-ECONOMIC STATUS

Previous research found on the topic of socio-economic status (SES) and achievement in VMI skills test show that learners of a lower socio-economic backgrounds consistently score lower in VMI skills tests than learners from a higher socio-economic background. Visual-motor integration, along with reading and writing progress has been shown to be sensitive to SES. VMI scores increase as SES increases (Lotz *et al.,* 2005:64; Dunn *et al*., 2006:952). This is reflected in the current study's findings.

Research lists the lack of resources and opportunities as the main factors that influence the achievement of children from lower socio-economic backgrounds (Dunn *et al*., 2006:952; Taylor & Yu, 2009:34; Singh & Franszen, 2011:43).

The gaps between advantaged and disadvantaged children need to be addressed before school entry in order to minimise the growing disparities between these two groups of children (Grissmer *et al*., 2010:1016).

GENDER

The difference between boys and girls is a topic that interests researchers. Gender differences in VMI skills have been investigated by numerous studies (Soderman *et al.,* 1999:13, Lotz *et al*., 2005:65; Duiser *et al*., 2013:79; Emam & Kazem, 2013:552; Coallier *et al*., 2014:4). Researchers have also investigated topics such as handwriting and writing readiness, as well as fine motor skills (also called manual dexterity), and the differences in these skills between the genders (Mäki *et al*., 2001:665; Junaid & Fellowes, 2006:8; Medwell & Wray, 2008:43).

The current study found that girls scored higher than boys in VMI skills, but this difference is not statistically significant.

With relation to their findings Duiser *et al*. (2013:80) discussed the possibilities that boys scored lower in motor coordination because boys find it more difficult when writing or drawing to stay neatly within the lines, with the lines acting as an extra task demand. Boys, while developing motor skills more quickly than girls, may on a cognitive level, have more attention difficulties: these are an important component of handwriting. Mäki *et al.* (2001:667) emphasises the need for detecting and remediating VMI skills deficits in boys as early as possible in preschool because girls tend to be more proficient in pre-writing skills (like VMI skills), already at the preschool level.

VISUAL MOTOR INTEGRATION SKILLS

Regarding VMI the current study found that there was no significant difference between the experimental and the control group in response to the intervention. It could be seen that the experimental group improved more over the intervention period than the control group did. This could suggest that the intervention programme had some positive effect on the VMI skills of the experimental group.

It can be noted that the current study showed the results of a predominantly gross motor intervention programme (Appendix F, PP:101) on the improvement of VMI skills. With the improvements found in the current study it can be said that gross motor activities can help improve VMI skills in children. No exact replicas of the study were found; most studies found used predominantly fine motor or occupational therapy intervention programmes (Dankert *et al.*, 2003:542; Poon *et al*., 2010:1554; Vinter & Chartrel, 2010:479; Van der Merwe *et al*., 2011:3; Van Jaarsveld *et al*., 2011:5; Dibek, 2012:1924; Ohl *et al*., 2013:507).

Recommendations

The current study implemented a gross motor intervention programme over 14 weeks, which included two sessions per week of 30 minutes of activity in each session. It is recommended that intervention programmes in future should be longer and have more sessions per week. This recommendation is based on evidence from other studies which found that significant results regarding VMI skills, by using different number of sessions per week and longer intervention programmes. Dibek (2012:1927) had a higher frequency of sessions with three sessions per week, over a 10-week period. Another study differed in length of intervention; Dankert *et al*. (2003:546) used an intervention that lasted eight months. Poon *et al.* (2010:1558) noted that a long-term and intense intervention programme is required in order to improve visual-motor skills (Poon *et al*., 2010:1558).

It is recommended that future studies use more fine motor and specific hand manipulation activities in the intervention programme, along with gross motor activities. Other interventional studies differed from the current study in types of exercises practised. Specific fine motor and occupational therapy activities were the main focus of other intervention programmes (Dankert *et al*., 2003:548; Poon *et al*., 2010:1558; Ohl *et al*., 2013:510).

VISUAL PERCEPTION AND MOTOR COORDINATION

The current study found no significant differences between the groups regarding both the supplemental tests of visual perception and motor coordination. It was found that the participants scored on average lower in visual perception skills than in motor coordination skills.

In visual perception skills, both groups improved over the intervention period. In motor coordination skills, however, the control group improved while the experimental group decreased slightly. The result regarding the motor coordination test could therefore show that the control group received better motor coordination practise than the experimental group. This could be because the control group spent more time in the classroom doing class work (drawing and worksheets) compared to the experimental group. The teachers were asked to keep the control group children seated on the classroom mat while listening to the taped children's stories during the intervention time. It was observed that the teachers on occasion allowed the children to continue with school work instead. This meant that the control children may have received more practise in motor coordination activities such as drawing and writing, which could have affected the results.

Recommendations

Intensive visual training was not included in the current study, which may account for the very slight improvement of visual perception skills within the experimental group. Beery and Beery (2004:16-17) state that any researcher who finds severe visual perception problems in a participant should refer that participant to a vision specialist or ophthalmologist to deal with any vision problems. This suggests that visual perception is difficult to remediate unless done so by a specialist or with the aid of eye glasses. Vinter and Chartrel (2010:479) used a specific visual training intervention programme when helping improve children's reproduction of letters. Poon *et al.* (2010:1554) is another study with very specific visual training activities included in the intervention programme. They used a non-motor intervention to improve visual perception skills. It may be recommended that in order to improve visual perception skills, a more specific visual perception intervention programme is needed.

Similarly as to visual perception skills the current study did not include very explicit fine motor coordination activities. It is recommended that future interventions include more fine motor coordination, pen and paper activities. Vinter and Chartrel (2010:485) found improvement in handwriting skills with a purely fine motor training intervention programme.

GROSS MOTOR SKILLS

The current study found no significant difference between the experimental group and the control group's response to the intervention programme regarding overall gross motor abilities. The experimental group's GMQ scores were improved a small amount over the control group. This result was mirrored regarding locomotor and object control skills.

It is important to note that the entire sample tested with the TGMD-2 scored relatively high gross motor quotient, locomotor and object control scores. The results show that most of the participants had almost reached the ceiling of the possible scores obtainable. This leaves very little room for improvement through an intervention period. This ceiling effect could account for the results found with the GMQ, locomotor and object control scores of the current study. This conclusion can be substantiated when looking at other research that used children with delays in fundamental motor skills as participants (Gursel, 2014:310; Logan *et al*., 2013:8). They both found that children with deficits in gross motor skills improved through intervention programmes.

Recommendations

It is recommended that future studies identify children with more severe developmental delays in fundamental motor skills to be part of intervention programmes.

Similarly, with regard to VMI skills interventional programmes, it is recommended that interventions include more contact time per week with the participants. Longer sessions, and intervention periods, as well as higher frequency of session per week were found by other studies to be successful (Goodway & Branta, 2003:40; Apache, 2005:1014; Draper *et al*., 2012:145; Kordi *et al*., 2012:359; Zask *et al*., 2012:11; Bellows *et al*., 2013:30).

It is recommended that studies attempting to improve specific FMS, like locomotor skills, should use activities that explicitly practice that skill. Studies that successfully improved participants' locomotor skills used solely locomotor activities relating to the TGMD-2, such as: running, jumping, hopping, galloping, skipping, sliding and leaping (Deli *et al*., 2006:11; Tsapakidou *et al*., 2014:3).

ADDITIONAL RECOMMENDATIONS

Based on the findings and conclusions of the study, some additional recommendations can be made.

- Individual sessions with children that have severe VMI skill deficits should be conducted, along with the group-based sessions. These individual sessions will allow the Kinderkineticist opportunities to observe and work on other developmental delays the child may have.
- A larger sample size over a greater geographical area would be more useful when attempting generalisations about the population.
- A larger sample size with an equal number of boys and girls would allow for a better interpretation of gender differences in VMI and gross motor skills.
- Preschool teachers should be guided and trained by specialists in the identification and remediation of VMI skills and gross motor skills problems. This will enable a school-based intervention programme to be performed, where specific activities can take place on a daily basis, supplementary to the curriculum.

LIMITATIONS

- The sample size for the study was relatively small, after excluding participants due to VMI skills scores.

- The small number of girls and the random distribution of girls across the experimental and control group did not allow for further investigation into gender differences.
- Time constraints due to the school term dates and holidays meant that the intervention programme was shorter than optimal.
- Due to the temperamental nature of children in preschool it could be said that the participants did not perform the testing according to their optimal ability on the given testing day.
- The temperamental nature of children could also have affected the experimental group's participation in the intervention programme sessions. The participants may not have given their utmost effort and concentration for each activity equally.
- It could be noted that some participants may have had co-morbidities. All participants had visual-motor deficits, but some may have had additional developmental delays not specifically investigated in the study. These possible co-morbidities may have influenced the effect of the intervention programme.

In conclusion the current study found that a gross motor intervention can be beneficial to preschool children's VMI skills. More research regarding gross motor intervention programmes and academic skills like VMI skills, reading and writing needs to be executed.

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APPENDIX A

Developmental Test of Visual Motor Integration

Step Number	Procedure
1	Each child received a sharpened HB pencil, with no eraser. The investigators carried extra pencils and sharpeners in case of breakages.
2	The Beery VMI Full Form test booklets were distributed to the children, while the following instructions were given: *Please do not open your booklets until I ask you to do so. The page with the hand pointing up should face you.*
3	It was ensured that each child was sitting centred at their desks during the testing, with the booklet placed centred and squared to their body. This was demonstrated by the occupational therapist, who gave the following instructions: *This is the way your booklet must stay on your desk until you are finished. This is the way you sit.*
4	If the child is under 5 years old, or a functional Beery VMI level of under 5 years is anticipated the booklet is opened onto page 2, for the child to begin the test with item 4. In this case, to ensure the test was completed fully, this procedure was followed, even with children 5 years and older. The following instructions were given: *Watch me. I'm going to draw a line here.* The investigators demonstrated the drawing of a top-to-bottom vertical line. The investigator points to the line and then to the blank box provided, and says: *Make one like that. Make yours right here.* The instructor moved around the class to each child and performed this.
5	When the child had completed this task, the instructor moved on to do the same with the next two forms; the horizontal line and then the circle. The test then began.
6	The occupational therapist demonstrated, and gave the following instructions: *Now open your booklet by turning from the top, like this, to page 4. Page 4 has forms in the top squares. It looks like this.* Then page 4 was shown to the group.
7	The occupational therapist explained to the children that they must copy the forms they see in the space below it. She said: *Copy what you see at the top of each*

	page. Make your drawing of each form in the space below it.
8	The occupational therapist explained that they must start with item 7, and showed them item 7. She said to the class: *Copy the forms in order. Start with item 7. Some of the forms are very easy, and some are very hard.*
9	The occupational therapist explained they must: *Do your best on all the forms, try each one, do not skip any.* The investigators repeated this instruction as needed, whenever the participants needed encouragement.
10	The occupational therapist instructed: *Remember; only one try on each form and you cannot use an eraser.*
11	Testing can be ended after all member of the group have made three consecutive failed attempts at reproducing forms. In this case, as stated in the manual, the group was allowed to continue to try completing every form in the test booklet.

Source: Adapted from Beery and Beery, (2004: 20-24)

APPENDIX B

Visual Perception

The following is a summary of the procedures followed during the administration of the Visual Perception test:

Step	Procedure
1	A stopwatch was used to keep to the time limit of the test. Exactly 3 minutes is allowed for this test. It was ensured that the participants were not holding a writing instrument during this test.
2	In this study the children tested were all older than 5 years, but to be safe the investigator began the test where one would normally begin with a child under the functional age of 5.
3	Begin with Item 4. The investigator places a finger pointing to the stimulus box number 4. The investigator keeps their finger next to this box until they move to the next item. The investigator says: *See this line? There is one more exactly the same below*. The investigator then sweeps her finger of the other hand down alongside the response box. The investigator says: *Point to the one that is exactly the same as the top one.* - The investigator makes a mark next to the response the participant gives, whether correct or incorrect, and if no response is given the investigator circles the item number above the task. - Whether the response was correct or not the investigator must then "teach" the task to the participant. The investigator talks the participant through the task, pointing to each response, saying if the stimulus picture is smaller than the one above, and saying the correct response is exactly the same as the one above.
4	Continue the same procedure as above for items 5 and 6. Test the participant, and then teach the participant.
5	Beginning with item 7 the investigator starts the stopwatch. No more teaching of the items is to be done from this point. The investigator moves through the items, and makes a mark next to the participants' responses.

	- Observe any irregular behaviours such as squinting, holding head too close to page, rubbing of eyes, or excessive talking
6	The investigator concludes testing exactly 3 minutes after starting. The investigator offers praise to the participant.
7	As stipulated by the manual, if the investigator suspects any problems with any of the participants' vision, the participant must be referred for a visual assessment.

Source: Adapted from Beery and Beery (2004:81-85)

APPENDIX C

Motor Coordination

Step	Procedure
1	The first three items of the motor coordination test can be observed during the Beery VMI administration. They are three motor tasks: - Climbing into and sitting in a chair without help - Holding pencil with thumb and fingertips (doesn't have to be only two finger grip) - Holding paper with one hand and drawing with the other hand
2	As the tests were performed on different days, no rest was needed before proceeding with the motor coordination test. A stopwatch is needed, exactly 5 minutes is allowed for this test. A sharpened HB pencil was used, as in the Beery VMI previously, and no erasing is allowed. The paper must be kept straight and centred.
3	The investigator begins with item 4A and demonstrates saying: *Watch me draw a line from the black dot to the grey dot, and try to stay in the road.* The investigator then points to the line at item 4B, and asks the participant: *Now you try it, draw a line from the black dot to the grey dot. Try to stay in the road.* - If the participant does not respond circle the item number, and repeat the demonstration and the instructions
4	Continue this procedure with items 5B and 6B.
5	The test begins with item 7. The investigator starts the stopwatch. The investigator gives the instruction: *Go ahead. Do as many as you can, don't rush and draw carefully. Don't skip any.* - From this point onwards there is no more teaching of the tasks as previously. The investigator may prompt the child by repeating: *Draw a line from the black dot to the grey dots, stay inside the road.* - Other brief prompts can occur when the participant does not lift their pencil, the investigator can say: *Go ahead and lift your pencil to start*

	new lines to finish the shape. - On items 17-21 only is the participant leaves out a part of the drawing, such as the tip of the arrow for example, the investigator may mention once per item, by pointing to the small reproduction of the picture above the item. The investigator says: *Have you done all the parts? Look at the little picture here; have you done all its parts?*
6	Once the participant has completed page 1, turn over to the next page, and continue with the test. The investigator says to the participant: *Some shapes on this page have fewer dots, and some have no dots at all. If there is a dot start there, if there is no dot, start drawing wherever you want. Remember to stay in the road. Try drawing each shape exactly like the small shape above it.*
7	The investigator must not stop the test after three consecutive failures. The test continues for exactly 5 minutes, unless the participant wishes to stop due to fatigue.

Source: Adapted from Beery and Beery (2004:87-89)

APPENDIX D

Locomotor subtest

The following tasks measure the child's fluidity and coordination of their body as they move from one place to another:

Task	Description
Run	The ability to advance steadily by spring steps so that both feet leave the ground for an instant with each stride
Gallop	The ability to perform a fast, natural three-beat gait. - child steps forward with the leading foot, followed by a step with the other foot to a position next to or just behind the first foot
Hop	The ability to hop a distance on each foot - take off and land three times on preferred foot, and then three times on the other foot
Leap	The ability to perform all the skills associated with leaping over an object - take-off on one foot and land on the other, a relatively long period where both feet are off the ground
Horizontal jump	The ability to perform a horizontal jump from a standing position - take-off and land on two feet, swing arms to produce force
Slide	The ability to slide in a straight line from one point to another

	- body turned sideways so shoulders align with a line on the floor, step with the leading foot, followed by a step with the trailing foot

Source: Adapted from Ulrich (2000:3,46-48)

APPENDIX E

Object Control Subtest

The following tasks measure the child's ability to throw, strike and catch various sized balls:

Task	Description
Striking a stationary ball	The ability to strike a stationary ball with a plastic bat
Stationary dribble	The ability to dribble a basketball a minimum of four times with the dominant hand before catching the ball with both hands, without moving the feet
Catch	The ability to catch a plastic ball that has been tossed underhand
Kick	The ability to kick a stationary ball with the preferred foot - rapid approach to the ball, and then kick
Overhand Throw	The ability to throw a ball at a point on a wall with the preferred hand
Underhand Roll	The ability to roll a ball between two cones with the preferred hand

Source: Adapted from Ulrich (2000:3, 49-51)

APPENDIX F

WEEK 1 SESSION 1		
FOCUS	EQUIPMENT	ACTIVITY
Warm up, reproduction skills, coordination		WARM-UP: Follow the leader - Children follow the researcher and copy exactly what the researcher does - The researcher performs different kinds of actions (run, skip, hop, stand on one leg, arms in the air, on tip-toes walking, etc.)
Directionality, laterality	Beanbags	ACTIVITY 1: Place yourself - Each child gets a beanbag and places it in front of them - They follow the researcher's instructions about where they must stand in relation to their beanbag - In front of, behind, to the left side, to the right side, underneath
VMI, upper body coordination	Hula hoops (hoops) Beanbags	ACTIVITY 2: Beanbag toss - The researcher places the 3 hoops out in front of the children, they must all stand behind a line and each gets 3 beanbags to toss into the hoops - The hoops are placed in a triangle formation, one close by, the other a bit further away and then the last even further away - For a second try, move the hoops even further away
Upper body strength and		ACTIVITY 3: Superman

coordination, core and postural control		- Children lie on their tummy - They listen to the researcher's story about superman and how he flies, the children "fly like superman" - Child must lift up their head, lift their legs (keeping straight knees) and lift their arms (straight out in front them), they fly for 10 seconds then rest again. - Do this 3 times
Proprioception		COOL DOWN: Angels in the snow - Children lie on their backs and move their arms and legs and make "snow angels"

WEEK 1 **SESSION 2**		
FOCUS	EQUIPMENT	ACTIVITY
Directionality, motor planning		WARM-UP: Follow the leader - Children follow the researcher and copy exactly what she does; the researcher focuses on left and right movements - Shuffle, run, gallop, star jumps, forwards, backwards
Upper body coordination and strength, laterality		ACTIVITY 1: Swimming

		- Children lie on their tummy, the researcher tells a story about the sea and the sharks that will catch them if they do not swim - Children on the command, lift their arms and legs similar to the superman position, and pretend to be swimming, kicking their legs and moving their arms up and down slightly - Swim to the left and swim to the right
Proprioception, upper body strength	Small medicine ball Larger medicine ball	ACTIVITY 2: Medicine ball roll - Children sit in a circle with everyone's feet touching, start with the small medicine ball - Roll the ball to each other - Progress to using the bigger medicine ball
Laterality, VMI	Bubbles	ACTIVITY 3: Bubble punch game - Tell children to show you their right hands, and place their left hand behind their back "stuck there with glue" - Blow bubbles to them, and they must punch and catch the bubbles with only their right hand - Progress to using their left hand to catch bubbles
Upper body coordination, midline crossing		ACTIVITY 4: "Mickey mouse build a house" clap game - Sit in a circle with the children, all close enough that knees are touching - Each person places their hand on their knee or the next child's knee, their

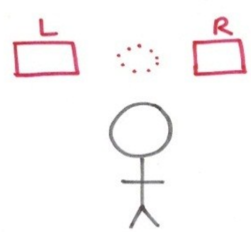
		right hand must be on top of the next child's hand, and their left hand must rest beneath the hand of the child on the other side - Sing the mickey mouse song, or other clapping game songs, and clap the hands as you go around the circle
Body awareness		COOL DOWN: - Sing the body awareness song "Head, shoulders, knees and toes"

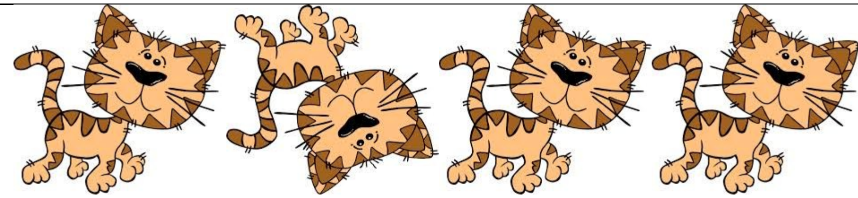
WEEK 2 SESSION 1		
FOCUS	EQUIPMENT	ACTIVITY
Warm up, motor planning		WARM-UP: Follow the leader - Children follow the researcher and copy exactly what she does - Run, walk, gallop, shuffle, skip, left and right
Proprioception, upper body strength		ACTIVITY 1: Animal walks - The researcher demonstrates the different animal walks and the children copy - Bear walk, crab walk, frog jumps, caterpillar walk

Proprioception, upper body strength	Hula hoops (hoops)	ACTIVITY 2: Rabbit hops - Place the hoops on the ground - Demonstrate the rabbit hop into each hoop, hands first, then the feet follow, let the children try
Directionality, motor planning	Small cones Hula hoop (hoop) Beacons Large cone	ACTIVITY 3: Obstacle course - Place 6 cones out in a line, place a hoop on a stand, place 5 beacons in a line, and 6m away a large cone - The children zig-zag through and around each cone, they climb through the hoop, hop with two feet over each beacon, run to the large cone and run around it and sprint back to the beginning 
Laterality, VMI	Bubbles	ACTIVITY 4: Bubble fun - Children show you their right hand, and place the left hand behind their back, “stuck” there - The researcher blows bubbles and they can only catch and pop the bubbles with their right and, change hands to only using their left hand

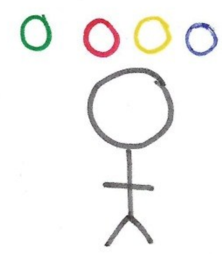
Proprioception, laterality		COOL DOWN: Angels in the snow - Children lie on their backs and move their arms and legs making a snow angel shape on the floor - They must only move their arms, then only their legs - Ask them to move just their right arm and leg, then just their left arm and leg

WEEK 2 SESSION 2		
FOCUS	EQUIPMENT	ACTIVITY
Warm up, upper body strength and coordination		WARM UP: Going to the beach - Sit in a circle, and tell the children a story about going to the beach, perform all the actions - Start by sleeping, then jump up and run to the kitchen and eat breakfast, then run to brush teeth, then run to car, then drive, etc., get to the beach and then eventually swim…then go back home
VMI	Small cones Small sponge ball	ACTIVITY 1: Kill the cockroach - Place 5 cones out in a row 1.5 m away from the children - The children take turns and roll the ball to the row of cockroaches an try and hit the cone and 'kill' the cockroach
VMI, upper body	Sponge balls	ACTIVITY 2: Throw and catch

coordination		- The children get into pairs with a ball for each pair, they stand opposite each other and throw and catch the ball - Progress to bouncing the ball in the middle and catching
VMI, directionality	Beanbags 2 baskets	ACTVITY 3: Beanbag toss - Place two baskets in front of the children 1m away, one basket on the left side and one on the right, and a space in between them - They take turns throwing the beanbags into the baskets on the researcher's command regarding which side they must throw to, left or right, or in the middle 
Visual perception	Printed pictures	COOL DOWN: Spot the difference - Print pictures for the children, for example: showing 4 cats, and one looking a different way to the other, or the picture being upside down - Ask which picture is different - Ask why they say it is different

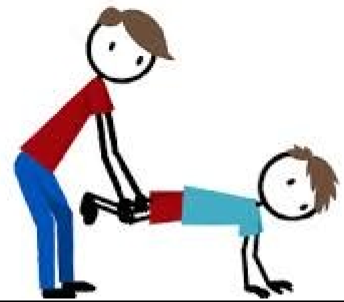
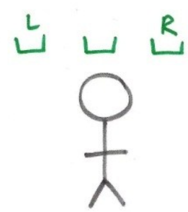
		

WEEK 3 SESSION 1		
FOCUS	EQUIPMENT	ACTIVITY
Warm up, motor coordination		WARM UP: Going on a picnic - All sit in a circle and tell the children a story about going on a picnic - Perform all the actions; eat breakfast, brush teeth, get into car and drive car
VMI, upper body coordination	Small cones Beanbags	ACTIVITY 1: Ice cream cones - Children pair up, and stand opposite each other, one holds a small cone upside down, to resemble an ice cream cone - The other child has 3 beanbags that are the ice cream. They try and throw the beanbag into the cone, and their partner holding the cone can move to catch the beanbags if necessary
VMI, upper body coordination	Hula hoops (hoops) Sponge balls	ACTIVITY 2: Bounce and catch - Children stay in their pairs, now with a hoop between them on the floor, and one holding a sponge ball

		- The children must bounce the ball into the hoop and to their partner, who tries to catch it and they repeat
VMI	3 sets of colored beacons	ACTIVITY 3: Bop the beacon - Set out 3 sets of beacons on the floor, a white beacon, red, yellow and blue beacon all on the floor in a row - Half the children sit quietly and watch while the other half each get a spot in front of a set of beacons - They sit in front of the beacon and on the researcher's command they hit the correct coloured beacon as instructed by the teacher - After several tries, the children swop over and the others get a chance 
Proprioception		COOL DOWN: Angels in the snow - The children lie on their backs - The researcher stands against a wall in front of them so that they can all see the demonstration and copy - The researcher and children move their arms first up and down along the floor in a snow angel movement - They move their legs in a snow angel movement

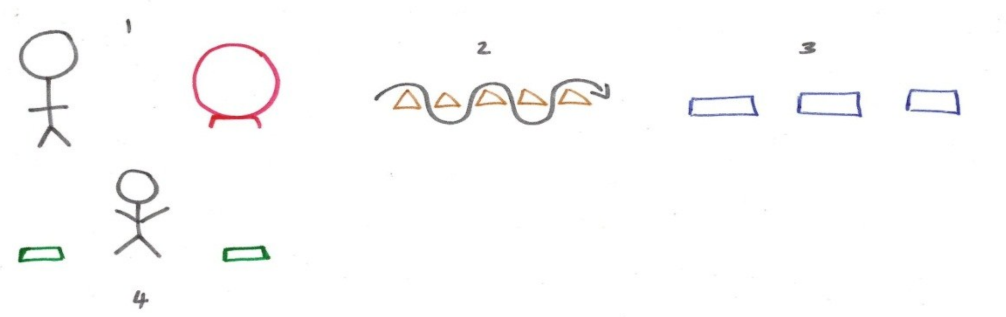
		- They try moving both arms and legs, slowly and accurately

WEEK 3 **SESSION 2**		
FOCUS	EQUIPMENT	ACTIVITY
Motor planning and coordination		WARM UP: Follow the leader - The researcher is the leader and the children follow her, and copy her exact moves - Run, hop, shuffle left and right sideways, - Try star jumps
Proprioception, upper body strength and coordination	Small medicine ball Medium medicine ball	ACTIVITY 1: Farmer and the bunny - Children sit in a circle, and the medicine balls are passed around to each child - The researcher then tells a story about a farmer and a bunny who wants to eat the farmer's carrots - The smaller medicine ball is the bunny, and the bigger ball is the farmer - The farmer chases the bunny around the circle, the children pass the balls, trying to get the big ball to reach the smaller ball
Proprioception, upper body strength and coordination	Beacons	ACTIVITY 2: Wheel-barrow walks - Two beacons are placed out as the course - The researcher helps each child to perform the wheel barrow walk, by

		holding the child’s knees, and the child uses his arms to walk 
VMI, directionality	Beacons Beanbags	ACTIVITY 3: Beans in beacons - Lay three beacons on the floor, upside down (open) about 1m away from the child - The child throws the beanbags into the open beacons, once the researcher has given the instruction as to which beacon it must go into, left, right or in the middle 
Laterality, proprioception		COOL DOWN: Angels in the snow - Children lie on their backs, this time eyes closed - The researcher gives instructions on lifting their right or left arm, then left

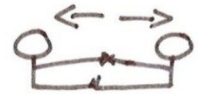
		or right leg - Try the angels in the snow with eyes closed

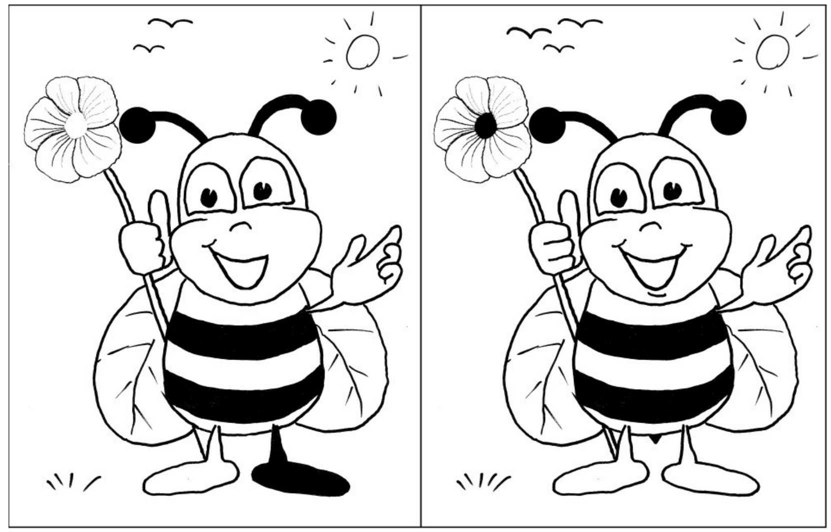
WEEK 4 **SESSION 1**		
FOCUS	EQUIPMENT	ACTIVITY
Warm up, motor planning and coordination	Whistle	WARM UP: Pirate's deck - Children pretend to be pirates - Children run around an area and the researcher blows the whistle and they stop and listen to the instruction - There are 3 instructions 1: salute the captain, 2: sailors sleep, 3: sailors run on water - With the salute the children stand on one leg and raise their right hand to their head and "salute" the captain - Sailors sleeping means the children lie on their tummies and stay there until the whistle blows and they jump up quickly! And run again - Sailors run on water means the children run on one spot as fast as possible
VMI	Hula hoop (hoop) Ladder square Beanbags	ACTIVITY 1: Underhand hoop toss - Place the hoop on a stand about 1m away from the child, place a blue ladder square on the other side of the hoop - The child gets 3 tries to throw the beanbags through the hoop and into the square

VMI, laterality, midline crossing	Bubbles	ACTIVITY 2: Bubble fun - The children show the researcher their right hand, and place the left hand behind their back - The researcher blows bubbles, and the children must catch the bubbles with only their right hand
Motor planning	Beanbag Hula hoop and stand Cones Ladder squares Beacons	ACTIVITY 3: Obstacle course - Children go through the obstacle course after the demonstration from the researcher - First the child throws a bean bag through the hoop on a stand, the child climbs through the hoop, the child picks up the beanbag and balances it on his head, he proceeds to walk zig-zag through cones placed on the floor, after this the child performs 3 one-legged hops into ladder squares, and runs to the end of the course and stands between two beacons, he performs three star jumps with the help of the researcher's instructions (arm and legs open, and arms and legs closed) 
VMI, manual dexterity		COOL DOWN: Drawing

		- The researcher sits with the children in a circle, each with a piece of paper, and a crayon - The researcher demonstrates drawing a shape, the children copy - Circle, square, triangle

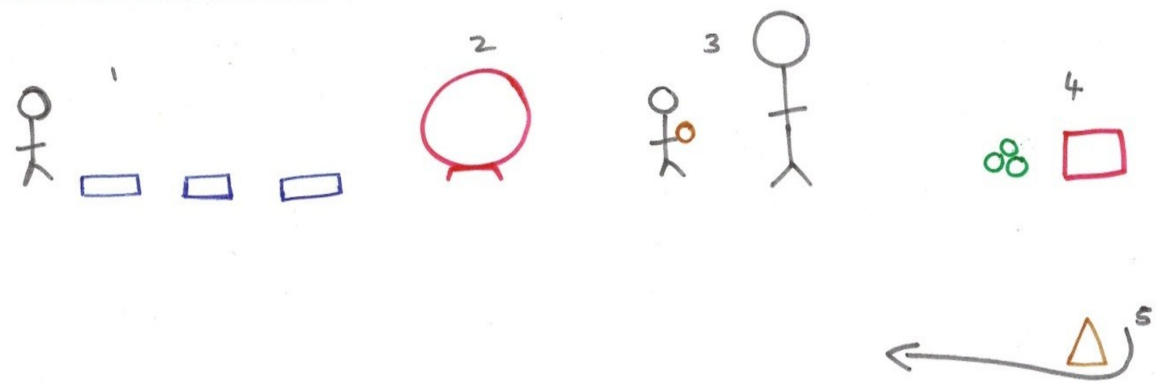
WEEK 4 **SESSION 2**		
FOCUS	EQUIPMENT	ACTIVITY
Motor planning		WARM-UP: Animal walks - Children stand in a row, and walk like the animal that the researcher discusses - Penguin walks: heels together, toes pointing outwards, waddle forward - Ostrich walk: bend down and hold your ankles and walk forward keep holding ankles the whole time - Horse: gallop like a horse - Giraffe: stand on tip toes and walk forward on toes, with arms up high in the air - Lion: walk on hands and feet (not knees)
Proprioception		ACTIVITY 1: Partner pull - Children pair up in same-sized pairs - They sit opposite each other and put their feet against each other's feet, they hold hands and pull their partner as hard as they can toward them

		 
Upper body strength and coordination, proprioception		ACTIVITY 2: Medicine ball catch - Children stand in a circle - The small medicine ball gets passed around the circle, from one child to the next - Try throwing the medicine ball around the circle, throw gently - Progression: The researcher begins and calls out the name of the child that must receive the ball next
VMI		ACTIVITY 3: Throw and catch - As in previous lessons, the children pair up and throw and catch the ball between them - Now the ball is smaller, and the task becomes more difficult to do (in this case the ball was too small, bigger balls will be used when performing this task again, until the children improve their catching skills)
Visual perception		COOL DOWN: Spot the difference - Print out a spot the difference activity sheet - The researcher sits with the children in a circle and explain the activity and

		the aim - Give some time for them to search the picture, ask them if they found any differences. (In this case the children had difficulty understanding, the researcher talked them through the task and the differences were found) 

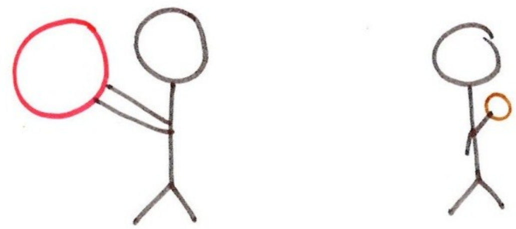
WEEK 5 **SESSION 1**		
FOCUS	EQUIPMENT	ACTIVITY
Warm up, VMI	Tennis balls in a basket	WARM-UP: Ball bail out - The researcher stands in front of the children, with a basket full of tennis balls - The researcher throws them out, and the children run to fetch them all, bringing one back at a time and putting it into the basket - The researcher continues to throw the balls out, it becomes a race to see if the

		researcher can empty the basket faster than the children can bring the balls back
VMI, upper body coordination	Cones Beanbags	ACTIVITY 1: Ice cream cones - The children pair up, one with a pile of 3 beanbags next to him and the other with a cone in his hand held upside down, the open part facing up - The children try throw the beanbags into the cones, trying to get 3 "scoops" of ice cream into the cone - They swop over when they get all 3 beanbags in - Progress by having the children stand a bit further away from each other
Proprioception, upper body coordination	Squeeze rings	ACTIVTIY 2: Squeeze and pass - The children sit in a circle - 3 squeeze rings are used, one light resistance, one medium resistance and one heavy resistance - The researcher begins with the yellow, light resistance ring, and they must squeeze the ring, hold it squeezed for 2 seconds, and pass on to their partner, repeat a few cycles - Use the medium resistance ring, and then the heavy resistance ring

		
Motor planning, VMI	Ladder squares Hula hoop on a stand Squeeze rings Basket	ACTIVITY 3: Obstacle course - Begin the course with 3 star jumps, the children perform hopscotch into ladder squares on the ground, the child climbs through the hoop on a stand, the child stands in front of the researcher and throws 3 scoops of ice cream into the cone the researcher is holding, the child moves to the squeeze rings, picks them up one by one and squeezes them and throws them into a basket about 1m away, he runs to the cone and runs back to the start line 

VMI	Connect the dots worksheet Pencils	COOL DOWN: Connect the dots - The children sit in a circle and each receives a pencil crayon and a "connect the dots" worksheet - The worksheet has a square, a triangle and a circle on it, a small replica of each shape is given just above the dots that depict that shape - The children connect the dots after the teacher demonstrates

WEEK 5 **SESSION 2**		
FOCUS	EQUIPMENT	ACTIVITY
Warm up	Music	WARM-UP: Musical statues - The children run around while music plays - When the music stops, they freeze on the spot until the music starts again
Proprioception, upper body strength and coordination	Skipping rope Whistle	ACTIVITY 1: Tug of war - Children pair up into equally matched pairs - Each pair gets a skipping rope to pull on - They play tug of war, the researcher blows a whistle to begin, after 30 seconds of tugging the whistle blows again for a short rest, play another 30 seconds and rest - Repeat 5 times

VMI	Sponge balls Hula hoops (hoops)	ACTIVITY 2: Basketball - In the same pairs as before, one child holds a hoop at their shoulder level, next to their body - The other partner has a medium sized sponge ball, and tries to throw the ball through the hoop, they get 5 tries before they swap - Children must first try throwing with 2 hands, afterwards change it to 1 hand throws 
Laterality, upper body coordination		ACTIVITY 3: Hand clap games - Children sit in a circle, with their hands resting on their knees or the knee of the child next to them - Each child's left hand is underneath the next child's hand, and each child's right hand is lying on top of the hand of the child on the other side - The researcher begins and claps the hand of the person next to her, and that person then claps the hand of the person next to him, and it continues around the circle - Sing a traditional song to go with the clapping

VMI, manual dexterity	Laces Large beads	COOL DOWN: Threading beads - Children sit in a circle and each receives a lace and 5 large toy beads to thread - The children thread their laces through the holes in the beads - Observe which hand they use and if they swap hands during the process 

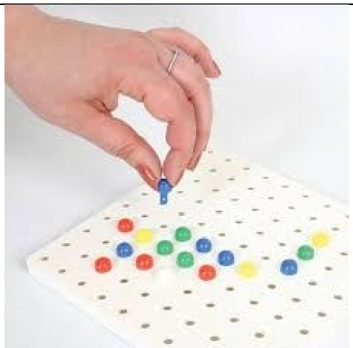
WEEK 6 **SESSION 1**		
FOCUS	EQUIPMENT	ACTIVITY
Warm up, VMI		WARM-UP: Ball bail out - The researcher stands in the middle of an open space with the basket of balls - The researcher throws out the balls one by one, and the children run and fetch them, bringing only 1 back at a time, and putting it into the basket - It is a race to see if the researcher can throw all the balls out before the children bring them back to the basket again

VMI, upper body coordination	Sponge ball Hula hoop (hoop) Tennis ball	ACTIVITY 1: Basketball - The researcher stands with the hoop held at just above the children's' shoulder height - They each get a turn, and 3 throws into the hula hoop - First start with a medium sized sponge ball, and a two-handed pass - Try a smaller ball like a tennis ball and an overhand one-handed pass - The other children stand in a semi-circle behind the front child as "fielders" ready to catch the balls
VMI, coordination	Tennis balls Cones	ACTIVITY 2: Roll in the goal - The children are paired up, with a tennis ball and goal set up along the wall with 2 cones, the goal is about 1.2 m wide - The researcher demonstrates the correct rolling techniques, with knees bending and a step forwards, and releasing the ball close to the ground - The children try roll the ball into the goals, the other partner can be a goalie and try kick the ball away, the children swop
VMI, upper body coordination	Sponge ball Tennis ball	ACTIVITY 3: Bounce and catch - The researcher is the partner for each child, as they take turns. The other children stand behind the front child and act as the fielders again - First begin with the bigger ball, the sponge ball, and bounce and catch the ball back and forth to the child - Once each child has had a chance and can perform the task with the big ball, progress to using the smaller ball and make it more difficult

Body awareness		COOL DOWN: Laterality and body awareness game - Children lie on their backs and close their eyes - They listen to the researcher's instructions and follow them - The researcher gives instructions like: raise your left hand, touch your left hand to your head, touch your right hand on your right knee, etc.

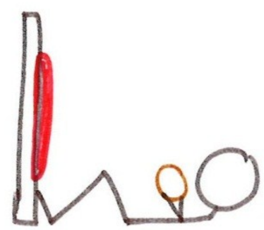
WEEK 6 SESSION 2		
FOCUS	EQUIPMENT	ACTIVITY
Warm up	Music	WARM-UP: Musical statues - Children run around the area while the music plays, when the music stops they must freeze on the spot - When they get the hang of that, tell the children that when they freeze they must stand on 1 leg until the music begins again
Directionality, VMI	Targets Prestick Tennis ball	ACTIVITY 1: Direction game - Targets are stuck on the wall, a red target circle in the middle and a target above and below it and on either side of it - The child stands about 1m away and throws the tennis ball over hand to the target specified by the teacher, use directional words to describe the target

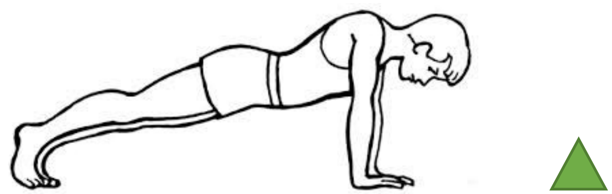
VMI, upper body coordination	Sponge balls	ACTIVTIY 2: Bounce and catch - Children take time to bounce and catch the ball on their own, they bounce and catch 5 times with themselves, and pass the ball to their partner who does the same - Use 2 hands to bounce and catch - Progress to dribbling if they can
Upper body coordination, motor planning, imitation		ACTIVITY 3: Clapping game - Children get into pairs - They must copy the researcher and clap the sequence you clapped - Clap twice with your 2 hands, then twice with your partners 2 hands (high 10) then twice on your knees, repeat - Change the pattern once the children correctly perform this sequence
VMI	Pegs Peg boards	COOL DOWN: Placing pegs - Use 5 pegs and a peg board - Each child gets a chance to place the pegs into the wholes on the board - Repeat as much as time allows

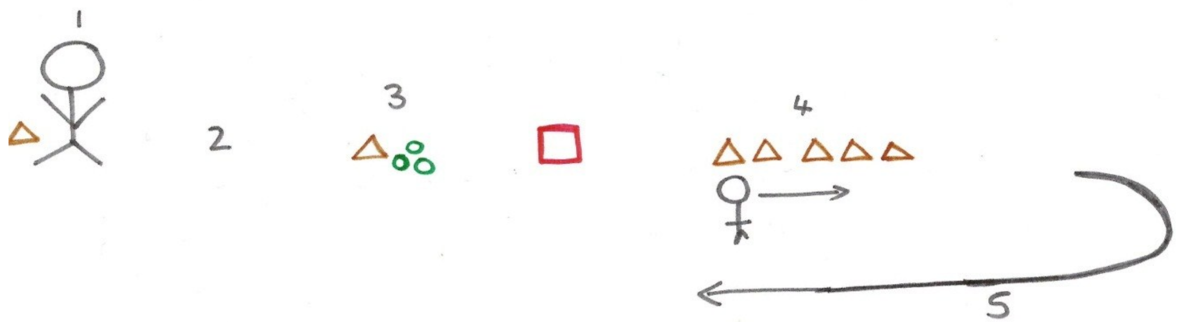
WEEK 7 SESSION 1		
FOCUS	EQUIPMENT	ACTIVITY
Upper body strength and coordination, motor planning		WARM-UP: Animal walks - The children line up on the one side of the area - They perform the following animal walks, as demonstrated by the researcher - Lion, frog, ostrich, bunny hops, caterpillar
VMI, upper body coordination	Red target circle Prestick Beanbags	ACTIVITY 1: Target game - Stick the red target on the wall about 1.2 m from the child, they each get a turn to throw the beanbags onto the red target - Keep score of the children’s attempts, 1 point each time they hit the target

VMI	Red, yellow and blue baskets Beanbags	ACTIVITY 2: Beanbag basket toss - Place 3 baskets out in front of the children, the first about half a metre in front of them, 1 a bit to the left and about 1m away , and 1 slightly to the right about 1.3 m away - They try get the beanbags into the baskets, they wait for the researcher to give the colour of which target basket they should aim for
VMI, Laterality	Balloons	ACTIVTIY 3: Balloon bombs - The researcher shows the children a blown up balloon, and explains that they must pretend the balloon is a bomb, and if the bomb hits the floor it will explode! - They must first use only their right hand to softly hit the balloon in the air, and afterwards use only the left hand
VMI, Manual dexterity	Pegs Peg boards	COOL DOWN: Pegs and pegboards - The children sit on the floor and place 5 pegs into the pegboard holes, each child gets a turn, repeat as time allows

WEEK 7 SESSION 2		
FOCUS	EQUIPMENT	ACTIVITY
Warm up, motor coordination	Whistle	WARM-UP: Sleeping giants - Children move around the space, and when the researcher blows a whistle and shouts “sleeping giants!” they stops and lie on the ground on their tummies and “sleep” until the whistle is blown again - Children can either run, skip or shuffle as their movement
VMI, upper body coordination and strength	Target Beanbags	ACTIVITY 1: Crunch the wall - Children lie on their backs with their feet against the wall - They have beanbags at their side and the red target is stuck on the wall - They crunch up doing a sit-up and throw a beanbag and try hit the red target, they sit back down again and get another beanbag 
VMI, upper body coordination	Balloons	ACTIVITY 2: Balloon bomb races

		- Children work in pairs, with a balloon, they all line up with their partners at one side of the space - The children softly hit the balloons into the air back and forth between them and their partner, and they slowly move from one end of the space to the other, not letting the balloon fall on the floor
Proprioception, upper body strength and coordination	Cones	ACTIVITY 3: Punch the cones - A row of 5 cones is placed in front of the child - The child gets into the push up position on their hands and feet, and they move sideways along the row of cones - As they walk sideways to a cone with their hands, they must lift 1 hand and punch the cone over, and walk to the next cone 
Visual perception, motor coordination	Pencils Paper	COOL DOWN: Copying and drawing shapes - The researcher sits in front of the children and draws the shapes, they must name them and try reproduce them - Progress to simply naming a shape and asking the children to draw it without any reference for them to look at

WEEK 8 SESSION 1		
FOCUS	EQUIPMENT	ACTIVITY
Warm up	Whistle	WARM-UP: Sleeping giants - Children move around the space, and when the researcher blows a whistle and shouts "sleeping giants!" they stop and lie on the ground on their tummies and "sleep" until the whistle is blown again - Children can either run, skip or shuffle as their movement, all the time pretending to be giants
VMI, upper body coordination	Tennis balls	ACTIVITY 1: Throw and catch - Using tennis balls is more difficult for the children to catch - The children pair up and throw the tennis ball to their partner and they catch and throw back - They must use 2 hands simultaneously
VMI, upper body coordination and strength, proprioception	Small medicine balls	ACTIVITY 2: Medicine ball catch - Children stand in a circle and gently throw the small medicine ball around the circle - Divide the group into 2 circles so they can throw and catch more times than using just 1 ball
VMI, proprioception, motor planning and	Cones	ACTIVITY 3: Obstacle course

coordination	Squeeze rings Basket	- Children take turns and go through the following activities in the obstacle course: - Start with 5 star jumps, jump on 1 foot; 3 times with the left foot and 3 times with the right foot, when they get to the cone with 3 squeeze rings they will squeeze each ring and throw it into a basket 1.2 m away, they move to a row of cones and they get into a push-up position and punch the cones as they walk along the row, they run back to the start line and give a high-5 to the next child 
VMI, manual dexterity	Plastic coins Posting box	COOL DOWN: Posting coins - Children sit in teams of 3 and each team gets a coin box and 15 coins - Each child gets a turn to post 5 coins into the box - They hold the box with 1 hand and post coins with their preferred hand - Repeat

WEEK 8 SESSION 2		
FOCUS	EQUIPMENT	ACTIVITY
Warm up	Cones	WARM-UP: Builders and diggers - Place the cones on the floor around the area, half of them must be knocked over and the other half must be upright - The children divide into 2 teams, half of them are builders and build the cones by turning them upright, the other half are diggers who knock down the cones - It's a race to see which team can win by having the most cones in their position
VMI, upper body coordination	Tennis balls	ACTIVITY 1: Throw and catch - Children each get a tennis ball to play with by themselves - They start with throwing the ball into the air and catching it - Try bouncing the ball on the floor and catching, using two hands to bounce

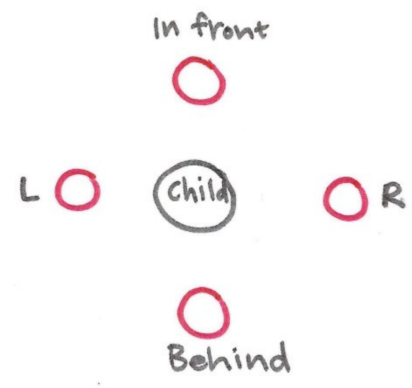
		and to catch - Progress to walking and performing the above
VMI, upper body coordination	Medium sized medicine ball Cones	ACTIVITY 2: Roll-a-Ball - Children get into pairs, they have a medium sized ball between them and each has a cone on the floor in front of them, they stand about 2 m apart opposite each other - They roll the ball on the floor using 2 hands, and they try hit the cone at their partner's feet, the partner sets the cone upright again and has his turn to roll the ball and hit the cone on the partners side
Proprioception, VMI, upper body strength and coordination	Beacons Tennis balls Cones	ACTIVITY 3: Obstacle course - Set out an obstacle course with the following activities: - 5 star jumps, wheelbarrow walk 1.5 m with the help of the researcher, tap the beacon while in the push-up position down a line of 5 beacons, throw and catch 5 tennis balls with the researcher, frog jump back to the beginning
Directionality	Pictures	COOL DOWN: Spot the difference - Have a page with pictures of giraffes, each facing a certain way and 1

		facing the other way, ask which 1 is different and why - Have other animals and pictures, have some upside down or on their side etc. and ask why they are different 

WEEK 9 SESSION 1		
FOCUS	EQUIPMENT	ACTIVITY
Warm up, VMI	Tennis balls	WARM-UP: Throw and catch tennis balls - Each child gets a tennis ball - They throw it up in the air and catch it, they repeat this throwing and catching
VMI, upper body strength and coordination	Small medicine ball Medium medicine ball	ACTIVITY 1: Numbers game - Children stand in a circle, and each child gets a number - The researcher calls out the number and the small medicine ball gets thrown to the child with that number, and this is repeated with all the

		children's numbers - Progress to using the larger medicine ball, and/or stepping further from each other
VMI	Tennis balls Beach bats	ACTIVITY 2: Balance bats - Each child gets a beach bat and a tennis ball - They hold the bat lying flat out in front of their body, they try and balance the tennis ball on the bats surface - Progress to the children walking slowly forwards while balancing the balls
VMI, upper body coordination	Hula hoop (hoop) Small soccer ball/ sponge ball	ACTIVITY 3: Dribble then goal! - The researcher holds a hoop up against the wall as the target, about 1.2 m away from the children - Each child gets a chance, they dribble the ball 4 times with 1 hand, they catch the ball with 2 hands and throw it into the hoop
VMI, laterality	Paper Crayons	COOL DOWN: Hand tracing - Each child gets a piece of paper and a crayon - They lay their hand down on the paper, and trace around it with the crayon, they do the same with the other hand - Talk about how each hand is different and it is easier to write/draw with one hand than the other

WEEK 9 SESSION 2		
FOCUS	EQUIPMENT	ACTIVITY
Warm up, VMI	Sponge balls Tennis balls	WARM-UP: Throw and catch - 3 children receive a medium sized sponge ball, and the other 3 receive a tennis ball - They throw and catch the balls like before, in the air, and catch them themselves - After a few minutes they swop over and get a different ball and try and throw and catch that ball
VMI, upper body coordination	Sponge balls	ACTIVITY 1: Target Games - They throw and catch the sponge ball as in the warm up - They throw and catch 4 times, and throw the ball into the hoop target the researcher holds up against the wall
Directionality, laterality	Cones	ACTIVITY 2: Bop the beacon - Each child sits on the floor legs crossed - Around each child place 4 cones, 1 in front of them, 1 behind them, 1 to their left and 1 to their right - The researcher stands in front of them, and goes through each beacon position making sure they all know the position names

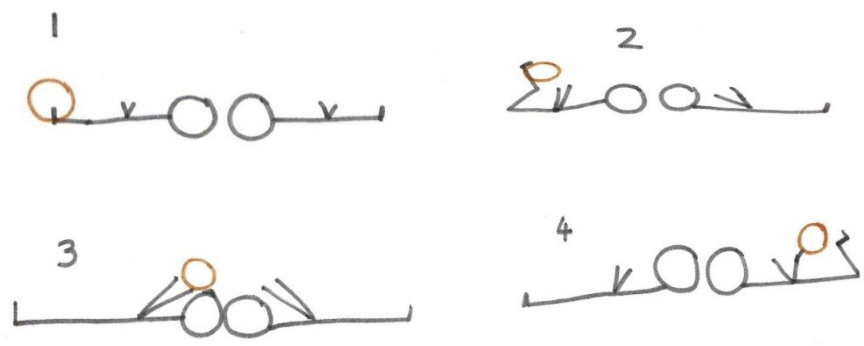
		- Then researcher calls out different positions and the children must place both hands on that beacon in that position - Progress: make the game faster 
VMI, motor coordination	Beach bats Sponge balls Tennis balls	ACTIVITY 3: Beach bat games - Children stand in a line, and each get a chance to play the game with the researcher - The child holds the beach bat, the researcher helps with the correct grip technique - The researcher throws a sponge ball to the child and he/she must try hit the ball back to the researcher, repeat this 5 times with each child - Progress: try use tennis balls that are smaller than sponge balls
VMI, manual dexterity	Connect the dots Pencils	COOL DOWN: Connect the dots - Each child gets a page with connect the dots drawings on - They connect the dots and draw the shapes

WEEK 10 SESSION 1		
FOCUS	EQUIPMENT	ACTIVITY
Warm up, VMI	Tennis balls Sponge balls	WARM-UP: Throw and catch - 3 children get a tennis ball and the other 3 get a sponge ball each - They throw their ball up in the air and catch it as it comes down - After a few times they swop their ball for a different one and try throw and catch that ball
Upper body strength and coordination, imitation	BOSU ball Small medicine ball	ACTIVITY 1: Mirror-mirror on the ball - The child stands on the ball part of the BOSU ball and balances - They hold the medicine ball - The researcher is the mirror and the child must copy each move the researcher makes exactly - The researcher does different movements using the ball in different positions

		
VMI, upper body coordination, motor planning	Hula hoops (hoops) Sponge ball	ACTIVITY 2: Bounce and catch - The children get divided into pairs - Between each pair place a hoop on the floor, each par gets a sponge ball - The children then play with their partners and bounce the ball in the middle of the hoop and to their partner - Demonstrate the correct technique of the bounce, emphasising that they should bounce forwards
VMI, directionality	Hula hoops (hoops) Beanbags	ACTIVITY 3: Hoop toss - The child stands in the middle of 4 hoops lying flat on the floor - 1 hoop in front, 1 behind, 1 to the left and 1 to the right of the child - The researcher gives the child instruction on where to throw the beanbag
Visual perception	Pictures	COOL DOWN: Spot the difference

		- Children sit in a circle with the researcher - The researcher shows them a "spot the difference" picture, and asks them to find any differences - They give their answers and the researcher talks them through each answer to ensure each child understands and sees the difference

WEEK 10 **SESSION 2**		
FOCUS	EQUIPMENT	ACTIVITY
Warm up, VMI, upper body coordination	Hula hoops (hoops) Sponge ball/small soccer balls	WARM-UP: Bounce and catch with a partner - Children are paired up - Place a hoop on the floor between them, and each pair gets a ball - They bounce the ball to their partner, the ball must bounce in the middle of the hoop - Teach correct technique
Upper body strength and coordination, motor planning	Sponge balls	ACTIVITY 1: Monkey ball passes - Children stay in their pairs - They lie down on their backs, with their heads touching each other and their feet on opposite ends - A ball is placed at the 1 partners feet - The first child picks up the ball with his/her feet and brings it up over her body, passing it to her hands - The first child then passes the ball overhead to his/her partner's hands, child number 2 then lifts his/her legs and takes the ball with his/her legs

		down to the ground - Child 2 lifts the ball up again with her feet, passes it to his/her hands and passes it back overhead to his/her partner - Repeat this 
VMI, upper body coordination	Beach bats Balloons	ACTIVITY 2: Balloon games - Children hold their beach bats flat in front of their body - They each receive a balloon - They lightly hit the balloon with the bat, up into the air and keep bouncing the balloon on their beach bat - Progress to walking forwards slowly while keeping control of the balloon with the bat
Proprioception, VMI, upper body strength and coordination	Cones Target Beanbags Hula hoops (hoops)	ACTIVITY3: Obstacle course - The children start with a wheelbarrow walk assisted by the researcher, they get to 5 cones in a row, they get into the push up position and move across the row hitting each cone, they move to the wall where they lie on their

		back and do a sit-up and once they are sitting up they throw the beanbag onto the target on the wall and sit back down again, lastly they throw the beanbags into the 3 hoops set out 1 close by and the other 2 further away
VMI, manual dexterity	Connect the dots pictures	COOL DOWN: Connect the dots - Use more difficult/different shapes, or shapes that they struggled with previously - Triangle, x and a cross

WEEK 11 SESSION 1		
FOCUS	EQUIPMENT	ACTIVITY
Warm up, VMI	Tennis balls	WARM-UP: Throw and catch - Using only tennis balls - Each child gets a tennis ball, and throws it up into the air and tries to catch it, they repeat over and over - Once they have got this correct, progress to the children walking around slowly while performing the action
VMI, motor planning, upper body coordination	Baskets	ACTIVITY 1: Bounce into the basket

	Sponge balls	- Set the baskets out in front of the children about 1.5/2 m away - Children work in pairs, 1 stands by the basket to collect the ball and throw it back to the other child - The child throws the sponge ball into the basket - Progress: children attempt to get the ball into the basket, by bouncing it on the ground first
VMI, proprioception, coordination	Hula hoop and stand River rocks Cones	ACTIVITY 2: Mountain climbing - Set out a short obstacle course - The children climb through the hoop on the stand - Set out the river rocks and cones alternating, the children jump on the balance rock with 2 feet, and off, and jumps over the small cones with 2 feet - The children caterpillar crawl for 2.5 m up to a basket, they pick up the squeeze rings 1 at a time and toss them into the basket 

VMI	Cones Sponge balls	ACTIVITY 3: Kill the cockroaches - The children work in pairs again, with 1 child manning the cones on the 1 side - Place 3 cones in front of the child, 2 m away - The child uses the sponge ball and rolls it and tries to knock down the cones - The other partner throws the ball back to his/her partner
Upper body coordination, laterality		COOL DOWN: Mickey Mouse clap game - Children sit in a circle and play the mickey mouse clap game

WEEK 11 **SESSION 2**		
FOCUS	EQUIPMENT	ACTIVITY
Warm up, VMI	Baskets Sponge balls	WARM-UP : Basketball - Children work in pairs, each pair gets a basket and a sponge ball - Set the basket about 1.5-2 m away from the child, and he must throw the ball into the basket - The partner collects the ball and throws it back to his/her partner, they swap after 10 throws
VMI, upper body coordination	Cones Beanbags	ACTIVITY 1: Ice cream cone catch

		- Children work in pairs and each pair has a small cone and 3 beanbags - 1 child throws the beanbags or “ice cream scoops” into the cone that his/her partner is holding at waist height - They swop over
VMI, upper body coordination	Beach bats Sponge balls	ACTIVITY 2: Beach bat games - Working in the same pairs the children get a sponge ball and bat - 1 child throws the ball for the other to hit with his bat - They swop over
VMI	Balloons	ACTIVITY 3: Balloon volleyball - Children work in pairs again, and each pair receives a balloon - They stand about 1.5 m apart and they softly hit the balloon to their partner who hits the balloon back to them - They must try keep the balloon off the floor
Imitation		COOL DOWN: Hand clap imitation - Children all sit in a circle with the researcher - The researcher claps a short sequence and the children must try and imitate the sequence - Give each child a chance to clap it out

WEEK 12 SESSION 1		
FOCUS	EQUIPMENT	ACTIVITY
Warm up, proprioception	Music	WARM-UP: Musical statues - Children run around while the music plays, when the music stops they freeze - When the children freeze they must get on their hands and knees in a push-up position and hold it their until the music starts again
VMI	Balloons	ACTIVITY 1: Balloon volleyball - Children are in pairs, and each pair receives a balloon - They softly hit the balloon to each other standing about 1.5 m apart - They must keep the balloon off the floor
VMI, upper body coordination	Beach bats Sponge balls Tennis balls	ACTIVITY 2: Beach bat games - Children are in pairs and each pair has 1 person with a bat and the other with a sponge ball - The child with the ball throws it to the child with the bat and he/she attempts to hit the ball back - Progress: once they have performed this correctly, they can move on to using a smaller ball like a tennis ball
Upper body coordination and		

strength, proprioception, VMI	Sponge balls	ACTIVITY 3: Crab walk soccer - Children get divided into 2 teams although the teams are not important - The children get into the crab position, with their hands and feet walking on the floor, with their pelvic bone pushed up into the air, their bums must stay lifted, and not touch the floor - The children walk around on the floor and kick the ball to 1 another 
Imitation		COOL DOWN: Hand clap imitations - Children sit in a circle with the researcher - The researcher make short sequences of claps and the children attempt to copy the researcher exactly - Give each child a turn to imitate the sequence without confusion of other children's claps

WEEK 12 SESSION 2		
FOCUS	EQUIPMENT	ACTIVITY
Warm up, VMI	Tennis balls	WARM-UP: Musical statues - Children run around the area while the music plays - When the music stops they must freeze on the spot and throw a tennis ball up in the air and catch it, until the music comes back on
Upper body strength and coordination, VMI	Sponge balls	ACTIVTY 1: Crab walk soccer - Children get into the crab walk position, and they have a ball at their feet - They must softly kick the ball as they walk like a crab to the other side of the space - Their partner stands at the other end, and they give the ball over to them and they do the same back to the opposite end of the space
VMI, upper body coordination, motor planning	Beach bats Balloons	ACTIVITY 2: Beach bats and balloons - Each child gets a beach bat, and a balloon between a pair - They stand opposite each other on each end of the space - They must bounce the balloon lightly on their bats, very gently and control the balloon on their bat as they walk to their partner
Directionality	Pictures of arrows	ACTIVITY 3: Follow the arrows

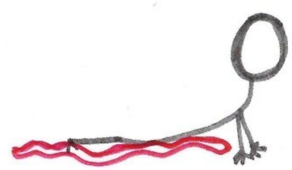
		- The researcher holds pictures of arrows pointing in different directions, left, right, up and down - The children must follow the direction of the arrows as the researcher shows them - Left and right arrows means to shuffle in the left or right direction - Up and down pointing arrows means jumping up or going down to the floor in a ball
Manual dexterity, VMI	Pegs Pegboards	COOL DOWN: Peg board fun - Children sit in a circle and place pegs in their peg boards

WEEK 13 **SESSION 1**		
FOCUS	EQUIPMENT	ACTIVITY
Warm up, directionality	Pictures of arrows	WARM-UP: Follow the arrows - Show the arrow pictures to the children, they must move in the direction the arrow is pointing - They either shuffle right or left, or jump up or go down to the floor in a ball
VMI, upper body coordination	Beach bats Balloons	ACTIVITY 1: Beach bat volleyball - Each child gets a beach bat and they pair up

		- They stand about 1 m away from their partner and they hit the balloon to each other - They can move further away if they are successful
VMI	Tennis ball	ACTIVITY 2: Number game - The children and researcher stand in a circle, the researcher holds the tennis ball to begin - Each person gets a number that they must remember - The researcher calls out the number of the next child who should receive the tennis ball - Throw the tennis ball around the circle - If numbers are too difficult to remember try using names in the beginning, and call out the names in quick succession
VMI	Sponge ball	ACTIVITY 3: Money game - The researcher stands on 1 end of the space, with a sponge ball - The researcher throws the ball over her shoulder to the children, and calls out a rand value that the ball is worth - The child who catches the ball "gets the money" - Each child must add up their total winnings, with help from the researcher
Manual dexterity, VMI	Laces Shapes for lacing	COOL DOWN: Threading lace - Children sit in a circle - They thread the laces through the lace holes in the shapes

WEEK 13 SESSION 2		
FOCUS	EQUIPMENT	ACTIVITY
Warm up, upper body strength and coordination		WARM-UP: Animal walks - Children stand in a row and perform each animal walk across the space - They perform the crab walk, bear walk, frog jump, caterpillar walk and ostrich walk
VMI	Hula hoops and stands	ACTIVITY 1: Hoop targets

	Tennis ball	- Set out a red, yellow and blue hoop on stands about 1.5 m away from the children - They each get a chance to throw a tennis ball into the hoop, the researcher calls out the specific colour they should aim for
Proprioception, upper body strength	Towels Basket Squeeze rings	ACTIVTY 2: Seal relays - Children divide into 2 teams, each team gets a towel to lie on - They children lie on their tummies on the towel, their hands on the floor in front of the towel, elbows straightened - They pull themselves across the floor, like a seal, using the towel to glide along the floor - They go to the other end of the space, where a basket and 3 squeeze rings are set up, and they stand up and squeeze and throw the rings into the basket before seal walking back to their teammate who takes a turn 
VMI, directionality	Pictures of arrows Tennis balls	ACTVITY 3: Follow arrows - The researcher shows the arrow pictures to the children

		- Each child has a tennis ball - If they see the up arrow they throw the ball up, if they see the down arrow they bounce the ball on the ground - Left and right arrows mean shuffling
VMI, manual dexterity	Laces Shapes for lacing	COOL DOWN: Threading laces and shapes - Children sit in a circle with their shapes and laces - They thread the laces into the holes in the shapes

WEEK 14 **SESSION 1**		
FOCUS	EQUIPMENT	ACTIVITY
Warm up, upper body strength and coordination		WARM-UP: Animal walks - Children perform the following animal walks across the space - Crab, caterpillar and bear walk
VMI	Sponge balls	ACTIVITY 1: Piggy in the middle - Children get into groups of 3. 2 children stand opposite each other about 3 m apart, and the third child stands in the middle of them - The 2 outside children work together to make sure the piggy does not get the ball, they throw the ball to their partner, the piggy tries to catch the ball - If the piggy does catch the ball he/she moves to the outside, and the child who missed the ball moves into the piggy position

Upper body coordination and strength, proprioception, VMI, directionality	Numbered lily pads Beanbags Arrow pictures Sponge ball Cones	ACTIVITY 2: Obstacle course - Set out an obstacle course for the children to go through - First they perform the seal walk across the room to 3 lily pads set out on the floor with numbers on, the child throws a beanbag onto each lily pad and call out the number he has thrown on (1,2,3) - There are arrows placed on the floor, first an arrow pointing left, so the children shuffle left, and get to an arrow pointing right, and they shuffle to the right, they see an arrow pointing up and one down, so they jump up and reach down to their toes - Walk forward to a sponge ball and cones set out in a row, they roll the ball and try hit each cone and "kill the cockroaches" - They caterpillar walk to another sponge ball, and they stand with the researcher and throw the ball back and forth 3 times and they run to the finish line
VMI	Sponge balls	ACTIVITY 3: Bounce and catch - In pairs the children stand opposite each other about 1.5 m apart - They bounce the sponge ball to their partner, and the partner catches it and bounces it back
Upper body strength and stability, VMI, manual	Paper Prestick	COOL DOWN: Drawing on the wall

dexterity	Crayons	- The researcher tapes a piece of paper on the wall for each child at about face height, they get crayons and they must draw on the paper on the wall

WEEK 14 **SESSION 2**		
FOCUS	EQUIPMENT	ACTIVITY
Warm up	Music	WARM UP : Pirates deck - Children pretend to be pirates, and as the music plays they run around the space, when the music stops they perform 1 of the following activities as the researcher calls out - Run on water (run on the spot), salute the captain (stand on one leg and salute), pirates sleep (lie on the floor on the tummy), scrub the deck (in the push-up position)
VMI	Cones Tennis balls Sponge balls	ACTIVITY 1: Kill the cockroach - Set out cones about 2 m away from the children - They try roll the sponge ball and hit the “cockroaches” 1 at a time - After this try using a tennis ball
VMI, upper body strength and coordination	Beanbags Numbered lily pads Basket	ACTIVITY 2: Obstacle course - Set out an obstacle course starting with tossing a beanbag onto 3 numbered lily pads and the child must call out the number of each lily pad (1,2,3)

	Squeeze rings Cones	- The children caterpillar walk to a basket and 3 squeeze rings, they squeeze the rings and throw them into the basket 1 at a time - They walk forward to a row of cones, they get into the push-up bridge position, and they gently tap cone and then walk in the push up position along the row to hit each cone - They stand up opposite the researcher and they throw beanbags into a cone she is holding, ice cream scoops into the cone - They run forward and bounce and catch a ball with the researcher again standing opposite them
Upper body coordination and strength	Small medicine ball Medium medicine ball	ACTIVTY 3: Farmer and the bunny - Children sit in a circle, and they pass around the small medicine ball, which is the bunny - The medium sized medicine ball is the farmer, the farmer enters the circle and gets passed around, trying to catch the bunny
Upper body strength and stability	Paper Prestick Crayons	COOL DOWN: Draw on wall - Tape pieces of paper on the wall for each child at face height - They draw pictures on the paper