Effects of a gross motor skills intervention on visual-motor integration of neuro-typical 5- to 6-year-old children

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SUMMARY

Children develop in a multidimensional manner. This implies that many developmental aspects influence each other. However, without gross motor skills (GMS), children lack the foundation for the development and integration of more specific motor skills. A paucity of information is available on how to effectively develop visual-motor integration (VMI) using GMS, therefore the current study focused on the development of GMS and visual-motor integration VMI in neuro-typical children between the ages of 5 and 6 years old (N=107). The primary aim of the study was to determine whether a GMS intervention programme could improve the level of VMI in neuro-typical children in this specific age group.

The participants for this study were selected from four schools of varying socio-economic backgrounds (Quintile 1, 2 and 5) in the Western Cape Province, South Africa. The participants were divided into an experimental and a control group. Both groups were tested pre- and post- intervention using the Test of Gross Motor Development (TGMD-2) and the Beery Test of Visual-Motor Integration (BTVMI). The experimental group participated in an eight-week intervention aimed at improving GMS and VMI by means of activities focusing on locomotion and object control skills. All activities required participants to be physically active and to engage their visual senses for tasks that required visual tracking or visually guided movements.

The study used a 5% ($p<0.05$) level as a guideline for statistically significant results. Despite the range in socio-economic backgrounds of the participating schools, the GMS and VMI abilities between the boys and girls were the same. The experimental group showed a significant improvement in overall GMS ($p<0.05$), locomotor ($p<0.05$) and object control abilities ($p<0.05$), as well as overall VMI abilities ($p<0.05$), visual perceptual skills ($p<0.05$) and motor coordination ($p<0.05$). Specific skills, such as jumping, galloping, leaping, dribbling, striking and catching improved significantly between the pre- and post-evaluations in the experimental group.

Time constraints imposed by school hours was a primary limiting factor, and to a lesser degree, the erratic nature of the participants. However, the findings of the study show that a GMS intervention is an effective method to improve children's VMI in this age group. A recommendation is that future research considers involving parents and teachers during the intervention period, as well as involving children from a larger geographical area.

The study suggests that VMI can be improved through a GMS intervention in children aged 5- to-6 years in a South African context.

Keywords: Gross motor skills; Visual-motor integration; Fundamental movement skills; Pre-school children.

OPSOMMING

Kinders ontwikkel op ŉ multidimensionele wyse. Dit impliseer dat ŉ groot hoeveelheid ontwikkelingsaspekte mekaar beïnvloed. Dit is egter so dat sonder die ontwikkeling van groot motoriese-vaardighede (GMV) kinders die grondslag vir die ontwikkeling en integrasie van meer spesifieke motoriese-vaardighede sal ontbreek. ŉ Gebrek aan informasie is beskikbaar oor hoe om visuele-motoriese integrasie (VMI) effektief te ontwikkel deur GMV, dus het die huidige studie op die ontwikkeling van GMV en VMI van neuro-tipiese kinders tussen die ouderdomme van 5 en 6 jaar oud (N=107), gefokus. Die primêre doel van die studie was om vas te stel of ŉ GMV intervensie die vlak van VMI in kinders in hierdie spesifieke ouderdomsgroep kan verbeter.

Die deelnemers aan hierdie studie is uit vier skole met verskillende sosio-ekonomiese agtergronde (Kwintiel 1, 2 en 5) in die Wes-Kaaplandse Provinsie, Suid Afrika, geselekteer. Die deelnemers is in ŉ eksperimentele en ŉ kontrole groep verdeel. Albei groepe is voor en na intervensie met behulp van die toets van groot motoriese vaardighede (TGMD-2) en die Beery toets van visuele-motoriese integrasie (BTVMI) geëvalueer. Die eksperimentele groep het aan ŉ intervensie van agt weke deelgeneem met die doel om GMV en VMI, deur middel van aktiwiteite wat op lokomotoriese- en objek beheer vaardighede fokus, te verbeter. Tydens alle aktiwiteite was die deelnemers fisies aktief waarin hul visuele sintuie betrek is vir take wat visuele navolging en visueel geleide bewegings vereis het.

Die studie het ŉ 5% ($p \leq 0.05$) vlak as ŉ riglyn vir statisties beduidende resultate gebruik. Afgesien van die omvang in die sosio-ekonomiese agtergronde van die betrokke skole, toon die resultate dat die GMV en VMI vermoëns tussen die seuns en meisies dieselfde was. Die eksperimentele groep het beduidende verbeteringe in algehele GMV ($p<0.05$), lokomotoriese- ($p<0.05$) en objek beheer vaardighede ($p<0.05$), sowel as in algehele VMI vermoëns ($p<0.05$), visueel-perseptuele vaardighede ($p<0.05$) en motor-koördinasie ($p<0.05$) getoon. Die eksperimentele groep het aansienlik in spesifieke vaardighede soos spring, galop, dribbel, slaan en vang verbeterings tussen die voor- en na-evaluerings getoon.

Die tyd beperkings wat deur die skoolure veroorsaak is, was die primêre beperking van hierdie studie en tot ŉ mindere mate was die wisselvallige aard van die deelnemers ŉ verdere beperking. Die bevindings van die studie toon egter dat ŉ GMV intervensie ŉ effektiewe metode is om kinders in die ouderdomsgroep se VMI te verbeter. Daar word aanbeveel dat toekomstige navorsing moet oorweeg om ouers en onderwysers gedurende die intervensie periode te betrek, asook om kinders uit 'n groter geografiese gebied in te sluit. Die studie stel voor dat VMI verbeter kan word deur 'n GMV intervensie by 5-6 jarige kinders in 'n Suid-Afrikaanse konteks.

Sleutelwoorde: Groot motoriese vaardighede; Visuele-motoriese integrasie; Fundamentele bewegingsvaardighede; Voorskoolse kinders.

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CHAPTER ONE

PROBLEM STATEMENT

INTRODUCTION

In the course of time, various approaches to child development have emerged. Most approaches stress the importance of taking individual development into account and viewing each child as a coordinated and structured entity developing as a whole (Bergman *et al*., 2000:38). Development is a continuous process from conception to maturity. Neuro-typical children follow a similar developmental sequence, yet the rate of development may vary from child to child. A neuro-typical child is an individual who thinks, perceives and behaves in ways considered normal to the general public and has no known intellectual or developmental delays. A child's development intimately relates to the degree of sensory integration, indicating how important the maturation of the nervous system is (Larkin, 2014:1003).

Sensory integration is a neurological process that organizes sensory information received from the body and the environment in order to make it possible for the body to move effectively and efficiently in its surroundings (Mozingo *et al*., 2016:93-94). Therefore, children whose sensory systems have not integrated fully are at risk of being over or under sensitive to stimuli received from the surrounding environment, which results in less than optimal reactions in response to external stimuli. Less optimal reactions to external stimuli is caused from, for example, over exposure to environmental conditions such as sight, hearing and touch, or from under exposure to learning new skills (Bergman *et al*., 2000:41). Children's sensory systems are over or under stimulated when forced into learning skills before their time or not encouraged to learn and develop new skills (Mozingo *et al.*, 2016:93-94). Sensory integration is the root of a child's holistic development and affects all areas of growth, be it physical, cognitive or social skills (e.g. language). It is important to specify these different areas of growth to bring a clearer understanding of the multidimensional manner in which humans grow and change. Understanding these areas is also necessary in order to appreciate the important role that sensory integration plays in a child's development (Bergman *et al*., 2000:41).

One of the first sensory integrations occurring in a child is the visual-motor system. Visual-motor integration is profoundly important for a child's advancement in many functional skills. For example, it is associated with a child's sporting abilities, academic related activities, social and emotional skills (Guo *et al*., 2014:214). All aspects influence each other and co-exist. In the same way that visual-motor integration affects the physical performance of a child, physical performance influences the cognitive abilities of a child (Guo *et al*., 2014:214). Motor activity enhances cognitive abilities, endorsing the need to develop a child's gross motor skills (Paloma *et al.*, 2014:52).

The current study aimed to explore the role that gross motor skills play in a child's overall visual-motor integration development. The focus of the study was on the gross motor skills of children in Grade R (5- to 6-years-old), because this is when the movement phase is mainly attributed to big muscle performance (Seils, 2013:245). Children need to perform big muscle movements in order to acquire motor skills that are essential for physical activity and to increase physical competency levels but also lay the foundation for successes in the classroom. This benefits children in many areas of life, ranging from academic achievement to health-related outcomes (Finni *et al.*, 2013:105).

Visual-motor skills allow a child to be successful when going through the process of learning and practising gross motor skills, such as object control and manipulation (Hartman, 2007:16). Furthermore, visual-motor skills allow a child to convert visual perception into motor functioning, accuracy and coordination (Goldstand, 2005:377). Gross motor skills refer to the internal processes that are responsible for moving the body in space. More specifically, these skills refer to the large muscles involved when moving through space, whether it is trunk movements, orientation or balance (Cameron *et al*., 2016:94). These skills also allow a child to make sense of his/her surroundings and formulate the correct motor movements in response to what he/she is seeing (Goldstand, 2005:378). In order for efficient and correct motor responses, the central nervous system must be able to take in and interpret the necessary sensory information correctly (Bonifacci, 2004:158). Visual-motor integration is one of the processes whereby a child receives visual stimuli, interprets it and executes a correct motor response. It is the ability of the eyes and hands to work in partnership and execute smooth and well-organized movement patterns (Sanghavi, 2005:34).

Gross motor skills form the foundation for many skills in popular physical activities, sport and games. These skills use large muscles and can be divided into locomotor and object control skills (Jones *et al*., 2015:858). Gross motor skills include skills such as jumping, walking and running (locomotor and non-locomotor skills), as well as all underlying physical abilities such as strength, agility, balance and flexibility. The performance of large muscle physical activities depends on all these skills. Along with gross motor skills come timed performance movements. Timed movements, such as ball skills, combine visual-motor integration with gross motor skills since they require object control tasks in which simple movements are repeated as quickly as possible (Bonifacci, 2004:159).

In children, gross motor skills are associated with a range of health related benefits such as an increase in physical activity, decreased body mas index (BMI) and improved cognition. Gross motor skills are also an important predictor of adolescent and adult sport participation. Therefore, when gross motor development is neglected at an early age, an individual will have a low gross motor skill competency, which often persists into adolescence and adulthood, reducing involvement in physical activities. For the betterment of these skills, Grade R is a vital age group to target because of the need for children to be taught at a young age and allowed sufficient time to practise before poor techniques develop. Opportunities to practise, encouragement and feedback can develop proficiency in children (Jones *et al*., 2015:857,858).

Visual-motor integration refers to the coordination of visual perceptual abilities and hand motor control, enabling eyes and hands to work together in order to move efficiently and appropriately. When the visual and motor systems have not been integrated and organised properly, a child may experience visual perceptual problems, which influence the way in which he/she may execute motor movements in response to visual stimuli (Brusilovskiy *et al*., 2015:7). Visual-motor skills influence motor movements and vice versa because both skills originate in the frontal lobe, and more specifically in the motor cortex. The premotor cortex is responsible for motor movements, such as gross motor skills, and higher order functioning, such as more intricate skills often involving visual-motor integration (Bonifacci, 2004:159).

Visual motor integration serves to perform the task of combining complex, conceptual structures from across all domains in order to link the body's processes (Guo *et al*., 2014:214). It helps the development of gross motor skills mainly regarding object manipulation, catching, throwing or hitting a ball. Developing these skills allows a child to be successful when performing movements and when partaking in different sports. Successful motor movements contribute to the physical well-being of a child because it enables an individual to participate in physical activities, games and sport. If a child's motor skills are poor, it is likely to lead to poor sporting abilities and even poor social skills (Logan *et al*., 2012:305). Strong visual-motor integration also results in correctly coordinated body movements for tasks that require manipulating objects. This further demonstrates the complexity and interrelatedness of the different domains of a person and how the integration of visual-motor skills can help to improve major areas of development (Cameron *et al*., 2016:95).

It is clear from previous research (Goldstand, 2005:378; Hartman, 2007:16; Guo *et al*., 2014:213) how complex the visual system is and how it impacts many human functions from physical development through to health and cognition. Gross motor skills are fundamental building blocks in a child's development and advanced through sensory integration activities. However, sensory systems are interlinked and when one system is not operating optimally, the other systems suffer as well, thus promoting the need for combined sensory integration approaches like visual-motor integration.

PROBLEM STATEMENT

Although previous research has shown that gross motor skills (GMS) have a significant connection to the level and development of visual-motor integration (VMI), which affects both cognitive and executive capacity of a child, only a limited amount of information is available on how to effectively develop VMI using GMS in children aged 5-6 years in South Africa.

MOTIVATION FOR THE STUDY

The main motive for this study was to develop a programme that improves the physical development of neuro-typical children. Many children are unable to develop their full potential due to their socio-economic backgrounds, geographical location and environmental and social factors. Giving children an opportunity to practise and learn gross motor skills allows a firm physical foundation to develop and make a holistic difference throughout adolescence and adulthood.

Most children wish to function at the same level as their peers, or at least function to the best of their abilities. Because humans are complex and all developmental aspects are intertwined, hindrances to optimal functioning can often be traced back to a specific area of development.

The current study will be beneficial for children and their education because it provides an opportunity to be active at a young age, as well as develop skills that will enhance the integration between visual and motor abilities. This study aims to develop children's gross motor ability, allowing for positive changes in hand-eye coordination and classroom related activities.

METHODOLOGY

Research design

This is a quasi-experimental study design that employed a quantitative methodology in order to assess the effects that a gross motor skills intervention had on the visual-motor integration of children. Through tests, administered pre- and post-intervention, the data were collected. A quasi-experimental design tests cause and effect relationship between variables (Darrah & Wiart, 2001). In order to measure the effects of the intervention, the design consisted of one experimental group that took part in the gross motor skills intervention over eight weeks and a control group that did not take part in the intervention.

Sample

Four schools in close proximity to Stellenbosch, with whom Kinderkinetics at the Department of Sport Science, Stellenbosch University, had a longstanding relationship, volunteered to participate in the study. All their Grade R classes were asked to volunteer to be part of the study implying a sample of convenience.

The reason for the sample size (N=107) was to include all the children of this age group in the intervention at the selected schools.

Inclusion criteria

The subjects had to be in Grade R and attend the selected schools. The parents/legal guardians of the participants had to agree and sign the informed consent forms and the participants had to sign assent forms.

Exclusion criteria

Children who were diagnosed with legal blindness (information was obtained from the teachers at the specific schools) were excluded from the study. Participants who did not participate in the intervention and participants who were absent from more than two of the lessons were excluded.

Procedures

The principal investigator and post-graduate Kinderkinetics students conducted pre- and post-evaluations during the research period. Data gathered during this period were analysed to determine the effects of the intervention programme by comparing the pre- and post-evaluations results. All subjects completed the same tests and the experimental group completed the intervention programme over a period of eight weeks.

The quantitative scientific test batteries performed pre and post the intervention were the Test of Gross Motor Development (TGMD) (Ulrich, 2000), and the Beery Test of Visual Motor Integration (BTVMI-6) and the Beery VMI Supplemental Test for Visual Perception and Motor Coordination (Beery, 2004).

Intervention

Following the pre-evaluations, the results were analysed and an intervention programme was designed based on the data. Thereafter, the experimental group underwent an eight-week intervention programme, consisting of one, 30-minute session each week. During the intervention, the control group continued with a normal school day. After the eight-week intervention a post-evaluation was conducted and results compared for improvements.

Place of study

The pre- and post-evaluations, as well as the intervention programmes, took place at the selected schools. The pre- and post-evaluations took place in the classrooms, as well as on the fields at the schools and the intervention took place on the fields and/or playgrounds of the respective schools.

Limitations

The limitations of the current study could have been that the sample size was too small, and therefore, results were limited and could not be generalised; absenteeism may have had an effect on the sample size. The time constraints of a school day could also be seen as a limitation of the current study.

STATISTICAL ANALYSIS

To investigate the effects of the intervention on the outcome measurements, a mixed model repeated measures ANOVA was used. In this model, the participants were included as random effect and group (experimental, control), time (pre and post), as fixed effects. The group*time interaction effect was specifically looked at to determine whether the change over time was the same or different between the groups. Relevant means and standard deviations will be reported, and a 5% ($p<0.05$) level was used as guideline for significant results.

CHAPTER TWO

LITERATURE REVIEW

INTRODUCTION

This chapter will discuss the importance of child development, with a specific focus on the areas of: 1) gross motor skills (GMS); and 2) visual-motor integration (VMI). Within the explanation of these two areas, this chapter aims to highlight the benefits of developing VMI and GMS, as well as the examination of the impact of gender and different socio-economic backgrounds on GMS and VMI. This chapter aims to discuss the link between VMI and GMS and delve into previous interventions regarding these two areas of child development.

CHILD DEVELOPMENT

Young children's correct and healthy growth and development is of utmost importance because it provides a foundation on which children are given the opportunity to develop their full physical and intellectual potentials (Bloem *et al*., 2017:119). Development will vary from child to child because certain characteristics, family and specific environments influence it. Physical health, cognition, language, social and emotional development all fall under the umbrella term of child development and each play a crucial role in preparing a child for school readiness (Anderson *et al*., 2003:32).

Many children do not have proper access to stimulating environments and/or caregivers with time to encourage and help healthy development; therefore, early childhood development programmes and interventions exist worldwide. These programmes are designed to improve the cognitive, physical and emotional well-being of pre-school children in order to set them up correctly for their school career (Anderson *et al*., 2003:34).

Children from lower income households tend to have less exposure to developmental opportunities; however, children from any income bracket are at a risk of not reaching their developmental potentials, and therefore, physical and educational interventions are beneficial for every child. Underexposure to development in physical health, cognition, language, social and emotional aspects of a child's life can affect brain development (Anderson *et al*., 2017:77). Neural processes are not developed and strengthened adequately, which affects the learning systems of a child. This ultimately affects a child's health and development in the long term (Anderson *et al*., 2017:77).

The importance of child motor development

The areas of child development are all interlinked. When one area improves, the other areas are also positively affected. For example, helping children to improve their movement performances can lead to an improved self-concept, and therefore, positively affect their social-emotional aspect of development. There are links among all the domains of child development; therefore, by improving one aspect the other aspects may indirectly improve as well (Isaacs & Payne, 2017:5).

The current study focused on the gross motor aspect of child development. Gross motor development refers to the changes that occur in big movements over time. Motor development in children aims to improve movement and challenge children relative to their achievement levels. If children are not encouraged to challenge themselves with regard to motor performance, they may experience developmental lags. Developmental lags occur when a child does not develop at a typically developing rate, in other words, at the same rate as his or her peers. This not only impacts the motor domain with regard to sporting skills and performing efficient daily functioning movement tasks, but it also impacts the other domains of a child's development. It may result in a poorer self-concept and negatively impacted educational skills and this may cause children to isolate themselves from their peer group and continue in a negative developmental cycle (Isaacs & Payne, 2017:5).

South African statistics

Over a million children are born in South Africa every year (Republic of South Africa, 2017:3). Every child has the right to health, education and development. When children do not receive the correct input with regard to these basic rights, the difficulty levels and costs to catch up later increase dramatically (Republic of South Africa, 2017:4). Surveys conducted over the past few years have shown that children from poorer households are less likely to have access to early learning programmes that encourage motor development than those from wealthy households. This creates a developmental lag for children coming from lower socio-economic backgrounds that may only become apparent in later years and result in them struggling to meet their schooling demands (Republic of South Africa, 2017:34).

A study conducted by Barhorst *et al*. (2014:370) examined the impact that gross motor development and VMI skills have on Grade 1 children's schooling performance from the North-West Province, South Africa. This study found a significant difference between overall VMI skills, visual perception, motor coordination and academic performance. This connection between VMI and academic performance in South African children proves the importance of finding different methods of improving children's VMI skills before formal schooling commences (Barhorst *et al*., 2014:370).

GROSS MOTOR SKILLS

Development of gross motor skills

Gross motor development is a process that can be measured by observing a child's motor behaviour over time. Motor behaviour is a child's observable actions and these movements fall into three categories: 1) locomotor; 2) manipulative and 3) stabilising movements. The locomotor movement category defines movements created by an individual that transports him/her from a fixed location to another on a surface. All locomotor movements require stability movements because the body is moving in space and must maintain equilibrium. Manipulative movements break down into both gross and fine motor manipulation (Carlson *et al*., 2013:517). Gross motor manipulation is when an individual imparts force on an object to move it. Fine motor manipulation refers to the movement of small muscles to create intricate movements, such as sewing or handwriting. Movements are not restricted to one of the three categories. Many actions span all three categories of stability, locomotion and manipulative movements (Gallahue *et al*., 2012:49).

Early on in human development, movements are primarily reflexive (Malina, 2004:51). Reflexes are involuntary movements that form the foundation for motor development and are actions that allow an infant to make sense of and interact with their immediate environment. This reflexive phase serves to play an essential role in helping a child make sense of his or her body in relation to the outside world (Gallahue *et al*., 2012:49). The reflexive phase begins in utero and continues until an infant is one year old. During this stage, an infant undergoes many changes. The motor cortex is not as highly developed as the lower brain centres, which cause involuntary reactions to stimuli. The reason for this is that reflexive movements are the infant's main way of seeking nourishment and receiving information around his or her body (Gallahue *et al*., 2012:50).

Over time these movements become more controlled as a child learns to master intentional control and coordination of involuntary muscle movements (Malina, 2004:51; Carlson *et al*., 2013:517). The higher brain centres develop more rapidly and over time, the lower brain centres have less control over muscle movements, resulting in the infant's reflexes gradually becoming inhibited. Movement changes from sensory-motor activity to becoming primarily perceptual-motor ability. This transformation means that the infant no longer merely reacts to stimuli; instead, he or she can process the stimuli and draw on stored information from similar stimuli to create a more controlled muscle response (Gallahue *et al*., 2012:51).

Once infants begin to create more controlled movements, they enter the rudimentary movement phase. This stage represents the basic voluntary actions needed for survival, which include stabilising movements that consist of gaining control of the head and neck, manipulative movements such as learning to move hands and fingers in an effective way and the start of locomotor movements, such as creeping and crawling. There is a rapid growth of the higher brain centres during this phase, resulting in rapid development of movement control, which prepares children for the next movement phase – fundamental movement skills (FMS) (Gallahue *et al*., 2012:51; Cameron *et al*., 2016:94-95).

The FMS stage is when children learn to perform actions more proficiently and practise movements that can translate into sport-specific skills over time (Bardid *et al*., 2017:184). These movements are an extension from the rudimentary phase and form part of the development of GMS (Gallahue *et al*., 2012:52). It is clear how important the mastery of each movement phase is in order to develop the next phase of movement. If reflexes do not integrate, the rudimentary phase is affected and this will almost always seriously affect the development of GMS (Gallahue *et al*., 2012:52).

The developmental rate specific to a child and the interaction he or she has with his or her environment influences his or her development. GMS develop in a child's pre-school years, and therefore, many studies have highlighted the need for free-play opportunities and structured Physical Education (PE) programmes during the school day (Goodwin, 2015:14). These opportunities allow a child to explore the environment and attempt new tasks, thus promoting potential mastery of GMS (Logan *et al*., 2014:49).

Optimal age to develop gross motor skills

Children in Grade R, between the ages of 5 and 6 are in the FMS stage (Bardid *et al*., 2017:184), and are at an optimal age for intervention because they are in a window period for development. Research has shown the importance of developing children's skills at this age because they are pliant, receptive and have not yet begun formal schooling (Hardy *et al*., 2010:504; Africa & Van Deventer, 2016:1960). Children's ability to perform motor skills develops at a prolific rate in the early years because they begin to acquire and enhance gross and fine motor skills. It has been reported that failure to develop a certain level of motor proficiency before formal schooling could result in a motor proficiency barrier, leading to a child's exclusion in a number of different physical activities (Morley *et al*., 2015:150).

It is important for GMS to develop in early childhood because these skills act as a precursor to positive consequences regarding weight status, physical activity and muscular strength/endurance throughout childhood and into adolescence (Barnett *et al*., 2015:1273). The development of GMS early in life also sets the stage for cognitive development because it is through movement that children are able to have the types of interactions with the world that lead to cognitive advances (Carlson *et al*., 2013:517).

Children between the ages of two and seven years fall into the FMS phase. This phase is divided into three phases: 1) initial stage (two to three years old); 2) emerging elementary stage (three to five years old); and 3) proficient stage (five to seven years old). Children learn FMS when they are testing out the movement potential of their bodies. The FMS period is a time when children learn to respond to environmental and task stimuli with motor control and movement. Fundamental movements such as locomotor skills (e.g. running and hopping), manipulative activities (e.g. throwing and catching) and body stabilising tasks (e.g. balancing and twisting), should be developed in the early childhood years (Gallahue *et al*., 2012:50).

FMS are the building blocks in a child's motor development that lead to sport-specific skills that are suitable for participation in sporting activities later in life (Barnett *et al*., 2010:1020). The FMS period in a child's life does not naturally develop as a child matures; rather it requires motor skill instruction and external encouragement and opportunities for a child to explore their environment (Barnett *et al*., 2010:1020; Gallahue *et al*., 2012:51). A number of experts in the field of child development have frequently written about a "natural unfolding" of children's motor skills and how motor skills will develop and be enhanced, as a child grows older (Gallahue *et al*., 2012:52). It is undeniable that maturation does play a role in the learning of fundamental movement patterns; however, it cannot be regarded as the only factor that leads to motor skill mastery. Environmental conditions play a huge contributing factor to how and when children develop FMS. Opportunities to practise, encouragement and instruction from others are all environmental elements that influence a child's motor skill development (Gallahue *et al*., 2012:52).

Under optimal circumstances, children should gain mastery over a majority of the movement patterns, which fall into FMS by the age of six. The reason is that at this age most children begin school and it is important to have a well-developed motor skill foundation to draw on when participating in organised movement activities in a schooling environment. This is when GMS learned in the fundamental movement phase extend into specialised movements (Gallahue *et al*., 2012:62).

Benefits of developing gross motor skills

GMS are hugely linked to a child's physical fitness. Physical fitness is a multidimensional component that involves children's performance of physical activities, such as aerobic fitness, muscle strength and agility. In order to improve all these components of physical fitness and to keep children motivated in developing fitness, it is important to ensure that children have developed the necessary GMS to allow for successful movement patterns (Gashaj *et al*., 2018:69).

Children who do not receive sufficient and correct environmental input in the FMS period of life may demonstrate developmental delays in their gross motor abilities (Barnett *et al*., 2010:1020). When a child experiences developmental delays from a young age, his or her self-concept, perceived physical competence and physical activity behaviour all have the potential of being negatively affected. Proficiency in FMS provides the foundation for children to develop an active lifestyle into adolescence and through to adulthood. A study done by Barnett *et al*. (2010:1020) revealed the positive correlation between FMS competency and participation in physical activity. Various other studies confirmed the findings that children with high levels of FMS and GMS are more active throughout the day (Callister *et al*., 2014:2).

In pre-school years, motor coordination and visual skills interrelate, develop together and form the basis of children's successful behaviours in the classroom. GMS form the foundation of a child's school readiness in at least two areas: 1) self-regulation; and 2) academic skills. Self-regulation is important because it allows a child to regulate his or her emotions and behaviours, including body movements. When children learn to self-regulate, they do not need to devote as much time and attention to behavioural tasks in the classroom (organising movements effectively in a seated position), and can rather spend time on other tasks and academic skills (Cameron *et al*., 2016:94-95).

Competence in GMS, which is based on the proficiency level of one's motor abilities and skills, is associated with positive health-related outcomes (Logan *et al*., 2014:48-49). Motor skill competence is necessary to independently engage in and experience one's surrounding environment (Logan *et al*., 2014:49). Some researchers have even stated that mastering GMS is a prerequisite to participation in physical activity later in life and leads to better physical well being (Garcia *et al*., 2008:291; Logan *et al*., 2014:50; Cameron *et al*., 2016:93).

The manner in which motor skills link to executive function and social behaviour is an underexplored area. It is known that VMI correlates positively with a child's ability to regulate social behaviour and executive functioning in the classroom, helping with future academic success. However, recent studies have shown that GMS, specifically those associated with ball skills, also positively correlate with children's social behaviour, therefore, helping children in classroom settings (Fraundorf *et al*., 2008:502; Anderson *et al*., 2016:396). The study performed by Anderson *et al*. (2016:396), using the TGMD-2 and BTVMI, focused on children's GMS and VMI, specifically object manipulation and ball skills, in order to help explain pre-school academic development. Results showed that VMI and object manipulation both improved children's classroom behaviour and enhanced their learning abilities (Anderson *et al*., 2016:405).

A recent study conducted by Gashaj *et al*. (2018:75) confirmed the idea that motor development and cognitive development should be seen as a symbiotic relationship. Improving physical fitness and motor skill development (with special attention to ball skills) has positive effects on visual-motor coordination. Moreover, an improvement in both these areas (GMS and VMI), leads to an improvement in the academic success of a child (Gashaj *et al*., 2018:76).

Individualised growth and learning of gross motor skills

A child's gross motor abilities and the way in which a child learns motor skills cannot be viewed and analysed as "one size fits all" (Gallahue *et al*., 2012:59). Some children learn faster than others learn, or will take to certain movement patterns more naturally than others and vice versa. Whether this difference is genetic or environmental, the circumstance is the same. Children develop at different rates and degrees to each other. It is of utmost importance and benefit to a child to measure him or her to his or her own standards and whilst doing so, to encourage learning, practise and growth to create an optimal environment for GMS development (Gallahue *et al*., 2012:59).

Gender

Differences in gender have been shown to affect children's GMS development. Studies have found that pre-school age girls perform better in locomotor skills than their pre-school male counterparts and the opposite to be true in terms of object control skills (Barnett *et al*., 2016:488).

A study conducted by Bardid *et al*. (2017:186) showed that boys and girls did not differ from each other with regard to locomotor and object control skills prior to intervention. However, after completing the programme, scores for both skills favoured the boys. Previous studies with similar aims have reported varying results on whether boys or girls improved more at the end of the intervention; however, more often than not, boys' object control skills increase more than girls' (Bardid *et al*., 2017:187).

Despite many studies having found small differences between genders in various and specific tasks, it must be noted that a considerable number of studies have failed to find gender differences in motor performance at Grade R level (Bonoti *et al*., 2014:13). The gender differences at this age have shown either to be too small or insignificant to notice, and therefore, too inconsequential to be reported. Therefore, it can be expected that overall, motor performance between boys and girls in Grade R will not vary significantly; however, boys and girls may differ in specific motor tasks (Bonoti *et al*., 2014:14).

Socio-economic status

The development of GMS in childhood is reliant on the growth and maturity characteristics of children. The environment in which a child grows up is a contributing factor to the way in which his or her motor development occurs. The quality of a child's living conditions, the amount of time caregivers are able to assist and encourage the child's gross motor development and overall socio-economic circumstances can play a huge role in a child's process of developing motor skill competency (Kambas & Venetsanou, 2010:319).

Children from lower socio-economic backgrounds tend to be outperformed in motor development assessment batteries by children from high-income backgrounds (Lejarraga *et al*., 2002:47). Lower income households often have less space for a child to play and explore, which prevents him/her from developing his/her gross motor skills. High-income households may also have access to educational toys and tools that families from lower income backgrounds may not be able to afford (Kambas & Venetsanou, 2010:320).

VISUAL-MOTOR INTEGRATION

Development of visual-motor integration

Visual-motor integration (VMI) is the degree to which visual perception and motor coordination, namely finger-hand movements, can work together to produce desirable and effective movements (Cho *et al*., 2015:411). The interaction of visual-perceptual and motor skills demands a sufficient level of hand-eye coordination in order to perform visual and spatial activities of daily living (Cho *et al*., 2015:411). Visual refers to merely seeing and taking in one's surroundings, whereas visual perception involves cognitive processes that clarify and make sense of what has been seen in an environment in relation to oneself (Gibson, 2015:3). Hand-eye coordination is movement generated from visual input and allows an individual to interact with objects and people in an environment (Battaglia-Mayer & Caminiti, 2018:499). Motor skills refer to neurological changes, often achieved through practise, that allow an individual to accomplish a motor task better than before (Diedrichsen & Kornysheva, 2015:227). Motor skills comprise of gross motor and fine motor skills. Fine motor skills make use of small muscles and result in slighter movements (e.g. finger-hand movements such as holding a pencil), whereas gross motor skills make use of large muscles, which result in big movements (e.g. jumping or kicking a ball) (Elferink-Gemser *et al*., 2015: 697).

VMI is most commonly associated with fine motor skills, therefore, skills involving small muscle movements (Gashaj *et al*., 2018:70). Fine motor integration can be described more distinctly as the development and movement of fingers and hands, essential for classroom tasks (Fontaine *et al*., 2014:182). Integrating visual input and motor output results in a child being able to produce planned motor tasks such as writing (fine motor skill), or catching a ball (gross motor skill) (Wild, 2011:1). A large part of children's functional skills depends on VMI because it is associated with self-care tasks and education-related activities, such as writing and reading, as well as helping with adjustments in pre-schoolers' social-emotional functioning (Guo *et al*., 2014:213). When visual-motor functions are not integrated early in life, children are at greater risk of seeming clumsy due to a lack of coordination. These children, therefore, stand a greater chance of shying away from academic and sporting activities because of not being at the same level as their peers (Bonifacci, 2004:158).

VMI has a sensory, perceptual and a motor component; therefore, the ability to coordinate visual perception with motor coordination is referred to as VMI (Africa & Van Deventer, 2016:1960). The sensory component is simply what the eyes have seen in a given environment, the perceptual component clarifies and comprehends what has been seen (Gibson, 2015:3), and the motor component is the movement in response to what has been seen (Battaglia-Mayer & Caminiti, 2018:499).

The following paragraphs below explain the different components of VMI and how they interlink.

Brain: Sensory and perceptual components

The perceptual component is in charge of visual processing because it visually perceives the environment and sends the sensory information to the brain where the brain attaches meaning to it (Gallese, 2016:127). Thereafter, the brain establishes an appropriate motor response to what has been seen and sends this response to the correct muscles to be activated in order to perform the action (Africa & Van Deventer, 2016:1960).

Brain: Motor component

The motor component is in charge of taking into account where an object is in space, categorising objects and organising actions directed towards objects (Gallese, 2016:128). Any intentional relation one develops with the external world has an intrinsic practical nature; therefore, it always carries a motor content (Gallese, 2016:129). The cerebellum's role in visually guided movement is to coordinate the action taking place. Where the cortex determines which action to perform, the cerebellum appropriately guides the movements as they are happening. The actual learning of the integration process of perceived visual stimuli and possible motor responses takes place in the posterior parietal lobe. This area of the brain calculates the spatial locations to which an effector, such as the hand, moves during visually guided movements (Carlson *et al*., 2013:516).

Brain: Perceptual and motor combined

VMI does not operate as separate components. The perceptual and motor components depend on each other and occur simultaneously as the body works out its surroundings and responses to external stimuli. The perception of body in space in relation to objects, as well as the perception of others' actions and the response towards the perceptions, all make use of the same brain circuits, allowing for appropriate actions towards objects (Gallese, 2016:128). Therefore, one cannot focus on only one component of VMI, as each component interlinks and feeds off the other one (Gallese, 2016:128). The perceptual qualities of calibrating body movements in space and identifying objects all depend upon the motor potentialities expressed by one's body (Gallese, 2016:129). The perception of objects is determined, constrained and ultimately constituted by the limits posed by what one's body can do with them (Gallese, 2016:130).

The VMI process is based in the posterior parietal and premotor cortex of the brain where specific parts of the body are selected for necessary movements (Willingham, 1998:561). More specifically, this area of the brain is activated when relations are formed between objects in the surrounding environment and the necessary motor responses for carrying out movements acting on these objects (Carlson *et al*., 2013:516). For example, when catching a ball, a person must calculate where to move his or her arms in order to catch the ball in the palms as opposed to another part of the arm such as the elbows (Willingham, 1998:562).

A common misconception is to comprehend VMI as an isolated motor response. The skills involved with VMI have, however, been identified as highly associated with other functional activities such as writing and reading. The skills involved with VMI can, therefore, be seen as multifaceted and influenced by a number of factors, such as eye-hand coordination, motor planning and perceptual skills (Dankert *et al*., 2003:542). A well-developed VMI system results in the ability to coordinate visual perception and motor execution, which depends on the integration of cognitive, visual, perceptual and motor skills. Visual perception and eye-hand coordination skills develop gradually during the pre-primary phase, preparing children to coordinate these skills in order for them to perform daily activities (Li-Tsang *et al*., 2017: 408).

Optimal age to develop visual-motor integration

Children need to develop an array of skills in order to transition comfortably and successfully into formal schooling. Mastering fine and gross motor skills within the first years of formal schooling is essential for a child's achievement in the classroom (Cameron *et al*., 2016:93). Right from birth, infants begin their developmental and learning processes. Children who do not receive adequate visual stimuli in the first five to six years of life experience developmental delays that can set them back as far as two years behind their peers of the same age when they begin formal schooling (Ramey & Ramey, 2004:475).

Benefits of developing visual-motor integration

Successful transitioning from pre-school to formal schooling is a major challenge in many children's lives. A study done by Gashaj *et al*. (2018:69) identified factors that are important for equipping children with necessary fundamental skills when progressing in their schooling career. One of these hugely important identified factors is VMI. The development of VMI enables children to master the skills of copying, reading and writing and, therefore, be successful in their early schooling years (Gashaj *et al*., 2018:70).

VMI is an indicator to measure a child's school readiness. It is crucial to allow a child ample opportunity to develop his/her visual-motor skills (Desoete *et al*., 2012:498). These skills set the foundation to future skills learned in the classroom such as: 1) reading and writing (Battaglia-Mayer & Caminiti, 2018:499); and 2) mathematics (Desoete *et al*., 2012:498).

If a child's VMI is underdeveloped for his or her age, it means that he or she has a problem with the visual or motor aspect or he or she has a problem with coordinating the two aspects. Decreased VMI function in a child can relate to problems in the classroom most commonly seen in writing when the child struggles to keep up with his or her peers. It can be related to trying to write with one's non-dominant hand (Battaglia-Mayer & Caminiti, 2018:499).

Studies have shown that pre-school children's reading and writing abilities are significantly related to their level of VMI (Kulp, 1999:159). Oral and written language is fundamentally different. Reading and writing are not innate. Most young children learn to speak, but not all become proficient readers and writers, therefore, implying that a skill such as reading is developed through brain structures that were designed for other reasons. The brain is wired to make sense of sound from a young age, but literacy is an optional skill that must be learned through visual practises that make use of already-formed neural pathways (Fisher & Frey, 2010:104). Actively engaging visual-motor senses and practising skills that involve VMI from a young age stands a child in better stead when it comes to developing classroom skills, such as reading and writing (Fisher & Frey, 2010:107).

VMI can be associated with a child's mathematical abilities. Visual-motor skills allow an individual to sort and count and visual perception skills permit an individual to find minor differences between numbers (e.g. between 6 and 9). Problems in VMI are traced back to problems in either of these two areas of visual-motor and visual perception (Desoete *et al.*, 2012:498). Studies show that children experiencing mathematical problems most likely also struggle with visual perception, motor skills and VMI (Desoete *et al.*, 2012:503).

Visual skills play an important role in educational skill learning. Research has found that vision is the triumphant sense of all human sensations (Fisher & Frey, 2010:107). This means that vision is arguably the best stimulus that can be used for early childhood learning. According to Medina (2008:233), visual information is a survival mechanism, which is why it is the first sense that the brain attends to. Each child learns differently, and will attend to visual cues in a unique manner. Therefore, classroom skills involving reading and writing should be taught using text, illustrations and movement (Fisher & Frey, 2010:107).

Research has made it clear that visual-motor skills form an integral part of a child's development before entering school because of the academic and social factors (Brooks *et al.*, 2011:1010) that it positively affects. Developing VMI allows children to engage in classroom and playground activities at the same level as their peers (Brooks *et al.*, 2011:1010). Failure to develop VMI skills leads to failure to attain school readiness skills and can result in an accumulation of negative effects on academic success and self-esteem that may only increase with age (Feder & Majnemer, 2007:312).

Gender

Some studies have identified gender differences in VMI skills, showing girls' skills to be superior to that of boys', although other studies do not support these findings (Lotz & Loxton, 2005:64). In a study conducted by Maki *et al*. (2001: 665), girls outperformed boys regarding the mechanics of handwriting at pre-school age. VMI is the most significant predictor of whether a child can manually produce legible letters smoothly and correctly (Chow & Tseng, 2000:84; Maki *et al*., 2001:644; Coallier & Rouleau, 2014:2). However, although it is true that more boys than girls struggle with handwriting, studies contributing to the development of the Beery VMI showed a difference between boys and girls that was not significant enough to be taken into account (Coallier & Rouleau, 2014:2).

A longitudinal study reported by Lachance and Mazzocco (2006:195), examined possible sex differences in maths-related tasks in primary school children. VMI is a strong indicator of a child's maths performance, and therefore, the assessments included measures of maths precision, visual perception tests and visual-motor tasks. There were no consistent findings to suggest that boys or girls are generally better in overall maths skills or VMI skills (Lachance & Mazzocco, 2006:195).

Socio-economic status

Low socio-economic environments can prevent children from attaining their developmental potential. One of the major factors contributing to this stunted potential is insufficient cognitive and physical stimulation. Poverty is associated with poor child development in terms of the lack of sensory-motor (affecting skills such as ball skills and handwriting), and cognitive development (Carter *et al*., 2007:145). These developmental lags may not be significant in the early years of schooling and development, but as children progress to higher grades or enter adulthood, the lag becomes more evident and learning gaps increase (Burt *et al*., 2005:744).

South African context

Studies that have evaluated children's VMI has mainly been conducted in developed countries with a dearth of research regarding children's VMI in developing countries where children are exposed to different challenges (Barhorst *et al*., 2013:302).

The Beery Test of Visual-Motor Integration is widely used in South Africa as a screening tool for assessing the visuo-motor abilities of children and VMI has been noted to be particularly sensitive to socio-economic status (SES) (Dunn *et al*., 2006:952). In the South

African context, VMI and physical motor skills have been identified as being particularly dependent on SES in early childhood years. Impoverished communities, with a lack of resources and overcrowded living conditions, characterise how many South African children are currently growing up. These living conditions can negatively affect a child's physical and educational development (Dunn *et al*., 2006:952).

Lotz and Loxton (2005:64) examined the VMI status of 5- to 6-year old South African children and found that physical motor development could be slow in children coming from low socio-economic backgrounds because of limited and restricted environments, especially when there is a lack of opportunity to use creativity to learn (e.g. surroundings to explore and objects to play with).

Many studies have shown SES to play a significant role in the development of VMI in children (Lotz & Loxton, 2005:64). The study conducted by Lotz and Loxton (2005:66), suggested that children who grow up in disadvantaged or impoverished communities may have significant VMI deficits when entering school due to developmental lags in the skills associated with VMI. Therefore, it can be said that children from disadvantaged backgrounds have fewer opportunities to develop school readiness skills when compared to children from higher socio-economic backgrounds. Therefore, there is a need to address this discrepancy in order to minimise the educational and physical development gaps between these two groups of children (Goodwin, 2015:25).

GROSS MOTOR SKILLS AND VISUAL MOTOR INTEGRATION

Gross motor skills develop before visual-motor integration

Past research on infant and child development has focused mainly on measuring cognitive abilities and fine motor skills. From this, interventions were developed aimed at improving learning and learning ability. However, cognitive measures with infants and children who are not yet attending formal schooling are poor at predicting future child development and the cognitive performance of a child. Cognitive and learning interventions are, in contrast, beneficial for school-aged children and adults. The role of gross motor development is of particular importance for children between birth and 6 years old/pre-school (Dawson *et al*., 2008:668).

GMS are considered the building blocks for which specialised movement patterns can develop from. GMS can develop naturally, and therefore, more specialised skills will be able to be learned from the acquisition of these gross motor movements. However, if children do not receive sufficient teaching, practise and feedback, GMS will not be mastered, and therefore, children will not be functioning at the optimal level for their age (Barnett *et al*., 2010:1020).

VMI falls under fine motor skills and involves, therefore, a more specialised movement pattern. When children develop mastery of GMS, VMI can be developed to the best of their abilities (Barnett *et al*., 2010:1020), because VMI is developed and enhanced through previously learned skills in a child's developmental timeline (Barnett *et al*., 2010:1022). In contrast, when children do not practise and receive correctional feedback during the development of GMS, they cannot develop VMI to its full potential. Therefore, children will not function at their optimal level for their age in terms of movement skills and skills associated with VMI (e.g. sporting and academic) (Dawson *et al*., 2008:670; Barnett *et al*., 2010:1021).

Relationship between gross motor skills and visual-motor integration

VMI is the foundation for academic and sport skills, with special attention to skills involving object manipulation (Coetzee *et al*., 2015:69; Africa & Van Deventer, 2016:1960), and it has been shown to be related to many educational benefits, including gross and fine motor skills, reading and writing, mathematical skills and overall academic achievement (Chan *et al*., 2015:8).

Sporting skills involving object manipulation rely heavily on the VMI system because these skills depend on hand-eye coordination to perform tasks successfully (Coetzee *et al*., 2015:69). A study performed by Barnhardt *et al*. (2005:138), using the BTVMI, found that children at the age of 13 years with poor VMI skills made significantly more errors in sport that involved a visual perception component. Visual perception is what leads up to an appropriate motor output once a person has made sense of what he/she sees and how it relates to him/her and his/her surroundings. The visual perceptual component in sport often correlates to ball skills or object manipulation components (Coetzee *et al*., 2015:69).

Human action observation is a way in which children and adults alike learn new skills (Calvo-merino *et al*., 2005:1243). Calvo-merino *et al*. (2005:1243) presented findings on brain activity when watching motor skills or actions that one has learned compared to watching skills and actions that one has not learned. Results of this study showed that brain activity increases when observing actions and the performance outcome has shown to improve more significantly if the action was learned previously. Therefore, these results emphasises the importance of the visual system when learning motor skills and it also stresses that skills and actions must be practised and retaught in order to develop (Calvo-merino *et al*., 2005:1248).

Handwriting lays one of the key foundations for academic success and VMI is known to play a crucial role in mastering the mechanical aspects of handwriting (Chow & Tseng, 2000:84; Dankert *et al*., 2003:542). A study done by Chow and Tseng (2000:84), found that children with higher scores on the standardised tests of VMI also displayed more legible and faster handwriting than those with lower scores. Researchers have since found similar results and conclude that VMI is a significant factor influencing the quality of children's handwriting (Daly *et al*., 2003:461; Feder & Majnemer, 2007:313; Donica & Lust, 2011:560).

A longitudinal study conducted by Gashaj *et al*. (2018:70), identified VMI and physical fitness as being indicators contributing to young children's schooling success. Developing GMS allows for more specialised movement patterns, and therefore, encourages children to be more physically active and fit. VMI and physical activity help to self-regulate children in the classroom and allow for a more conducive learning environment, as well as equip children with the necessary skills needed for classroom tasks and playground games with peers (Messier & Pagani, 2012:96; Gashaj *et al*., 2018:70).

Cognitive functions, such as VMI and motor functions, such as gross motor skills (GMS) rely heavily on each other and cannot be seen as two separate entities (Beeren *et al*., 2005:1). VMI requires input from the neuromuscular system, which includes all the muscles in the body and nerves sending information from the brain to the muscles and vice versa (Havu *et al*., 2014:104). For instance, the neuromuscular system and the process of visual motor integration are activated when a person sees and grasps an object. The brain must first visually recognise the object and attach meaning to it, after which the brain sends messages via the nerves to activate the necessary muscles for grasping the object (Havu *et al*., 2014:105). This compliments Piaget's theory, based on the idea that children learn from observable motor movements with objects. Therefore, children learn well from visual demonstrations and having an object to visually guide a motor movement (Elferink-Gemser *et al*., 2015:697).

Benefits of developing visual-motor integration through gross motor skills

Gross motor skills are the internal processes responsible for moving the body or parts of the body in space. Gross motor skills are not only just movements, but they also refer to the cognitive processes that give rise to movements. Gross motor skills involve the interaction of the movement systems (i.e. body parts) and the cognitive system (Cameron *et al.*, 2016:93).

Children with lower GMS have lower VMI skills. Gross motor skills are defined as muscles using large, force-producing muscles of the trunk and limbs (Logan *et al.*, 2014:49). Research proposes that VMI is more strongly related to motor coordination than to visual perception, suggesting that motor skills play a central part in developing VMI (Aden *et al.*, 2018:2). Motor skill learning refers to the increasing spatial and temporal accuracy of movements that occurs with practise. When one or more control processes becomes tuned to a particular task, motor learning occurs. Therefore, by combining two systems such as visual and motor, both systems improve and the accuracy of movement's increases as learning occurs (Willingham, 1998:559).

A study conducted by Bonifacci (2004:160) evaluated the relationship between motor ability, perceptual skills and VMI of a neuro-typical sample of 6- to 10-year-old children. Past research has alluded to the idea that there is a strong link in terms of the role the cerebellum plays between motor ability, perceptual skills and VMI. In all three developmental aspects, the cerebellum controls motor processing, and therefore, it has been assumed that by improving one function, the others will also benefit (Bonifacci, 2004:160). Bonifaccis's (2004:164) study confirmed the relationship between these aspects because children with higher motor ability exhibited higher perceptual skills and VMI, whereas children with lower motor ability displayed lower levels of perception and VMI.

VMI also serves as the foundation for sport skills. According to Africa and Van Deventer (2016:1961), perceptual and motor components must be integrated in order for the brain to make sense of its environment and activate appropriate muscle groups in response. Bardid *et al*. (2017:185) implemented an FMS intervention that included VMI skills in the activities. Participants consisted of 280 boys and 243 girls between the ages of 3 and 8 years. Participant's FMS skills were evaluated using the TGMD-2. At the end of the intervention, it was concluded that both boys and girls who participated in the intervention made progress in their locomotor and object control scores compared to the control group. These findings are in line with previous interventions focusing on FMS (Bardid *et al*., 2017:185).

The relationships between motor skills competency and cognitive skills in typically developing children before the age of 13 years was examined in a systematic review by Elferink-Gemser *et al*. (2014:697). After analysing many interventions combining both gross motor and cognitive abilities such as ones involving VMI, it was concluded that there is a correlation between the two. The correlation was particularly evident in interventions that developed cognitive and VMI abilities through means of GMS activities (Elferink-Gemser *et al.*, 2014:698). Another study by Gashaj *et al.* (2017:170) investigated the effects that a GMS intervention had on 5- to 6-yeard old children's fine motor skills and cognitive abilities. VMI was one of the evaluated skills to determine fine motor and cognitive ability. 156 children from different socio-economic backgrounds took part in this study. There was a significant correlation between GMS and VMI, despite the socio-economic backgrounds of the children (Gashaj *et al.*, 2017:171).

Child development is multifaceted and interlinked (Isaacs & Payne, 2017:5), and occurs through active exploration of the environment. When children are actively practising GMS and exploring their own levels of competence in this regard, they are not only developing and improving GMS; they are actually developing many other facets of development in the process. Developing a child's GMS lays a foundation for other skills to be positively impacted in the process. When children explore their environments, interact with their surroundings and improve their motor skills while doing so, VMI is enhanced, because different aspects of child development are linked (Messier & Pagani, 2012:96).

INTERVENTION

Empirical evidence suggests that gross and fine motor skills can be improved with practise (Logan *et al*., 2914:49). Physical interventions are of utmost importance early in childhood because allowing children an opportunity to engage in, attempt and practise new tasks has been shown to build a child's perception of his or her own competence, and in turn, influence his or her persistence in a task (Fjortoft, 2004:22; Garcia *et al*., 2008:292).

In the same way that a child must be viewed as having many domains making up a whole, interventions must also be designed with this concept in mind (Fjortoft, 2004:22; Bjorklund & Causey, 2017:99). Merely implementing physical activity may not always be enough because the environment where this takes place is also of great importance. Environments need to stimulate exploration and create challenges for children in order to develop and enhance their physical, social, emotional and cognitive development (Fjortoft, 2004:22). The ecological approach to development highlights the interrelationships between an individual and their environment. Interventions should, therefore, involve complexity in the environment in the form of equipment used or making use of the natural environment in a given setting (Fjortoft, 2004: 22, 38).

Interventions focusing on VMI skills of a child must be implemented as early as possible. Deficits in VMI skills affect a child's schooling career and should, therefore, be practised, enhanced and/or remediated before formal schooling commences. This enables children to cope with school stresses and avoid delays between them and their peers (Dunn *et al.*, 2006:951; Goodwin, 2015:28).

VMI is a multisensory skill, and therefore, requires a multisensory approach when designing an intervention programme to enhance the skills associated with VMI (Dankert *et al.*, 2003:543). In a study done by Hadwin and Zwicker (2009:46), a multisensory intervention was compared to a purely cognitive-based intervention and the effects that these interventions may have had on children's handwriting skills (a skill that relies heavily on VMI). Results were not vastly different; however, the multisensory approach did produce better results in terms of the children's VMI scores being higher on the Beery Test of VMI than those of the children having participated in the cognitive-based intervention (Hadwin & Zwicker, 2009:46).

GMS develops before VMI, yet these two areas of a child's life still follow similar developmental timetables (Abdelkarim *et al.*, 2016:325); therefore, there is great value in developing one skill through the other. It is logical to promote VMI through a GMS intervention for the reason that GMS are, generally speaking, more developed than VMI in children between the ages of 5- and-6-years. GMS interventions focusing on improving the VMI of children are most successful when implemented before a child begins formal schooling because this is when a child will be most receptive to new skills surrounding these two aspects of development. These two aspects are also of utmost importance for the success of a child's future school career (Abdelkarim *et al.*, 2016:325).

Interventions aiming to improve the VMI of children should include activities and tasks that stimulate visual senses (Gashaj *et al*., 2018:76). For example, a study conducted by Anderson *et al.* (2016:396) focused on improving the VMI skills in 3- to 5-year old children. It was found that tasks involving visual stimuli, like objects, encouraged children to interact with what they had seen. This promoted GMS through object manipulation activities, as well as VMI, because children needed to make sense of their visual surroundings in order to perform appropriate motor responses acting on the objects (Anderson *et al.*, 2016:396, 397).

For the purpose of this study, it is important to focus on the physical development aspects; however, due to research showing a correlation between cognitive skills and motor skills and their combined effect on a child's success at school and in the classroom (Gashaj *et al.*, 2018:76), the cognitive aspect (in this case VMI), will not be excluded or overlooked in the intervention.

CHAPTER THREE

METHODOLOGY

INTRODUCTION

Chapter Three outlines the research methodology used to conduct the current study and explains how the principal researcher collected and analysed the data. Furthermore, it aims to explain how the current study attempted to improve the visual-motor integration (VMI) of neurotypical Grade R children by participating in an eight-week gross motor skills (GMS) intervention programme.

RESEARCH DESIGN

This study made use of quantitative data in order to assess the effect that the GMS intervention had on the VMI of neurotypical children in Grade R. The research design is typified as quasi-experimental because the participating schools were not randomly selected, but chosen because of the relationship that the Department of Sport Science at Stellenbosch University has with these schools.

Different research design methods are available, and therefore, studies may differ in design. A quasi-experimental design makes use of a specific treatment and then aims to measure whether the treatment had a certain effect on an outcome. In studies that involve human participants, treatments tend to be in the form of manipulations. In order to assess the effect of a treatment, researchers need to determine how things were before the treatment was presented, thus allowing conclusions to be drawn after determining how things were after the treatment. A quasi-experimental study design usually makes use of a control group that does not receive treatments/manipulations, whereas the experimental group does. Participants partaking in a quasi-experimental study are not randomly selected and the groups (control and experimental) are not randomly divided, instead they are chosen and divided based on convenience (Newhart & Pattern, 2017:18).

AIMS AND OBJECTIVES

The main aim of the current study was to determine whether a GMS intervention could enhance the VMI of neuro-typical children in Grade R, which took place at the children's respective schools over a period of eight weeks. VMI is a critical skill to enhance as early as possible to promote school and sporting success. Many children do not recognise or develop their true academic and sporting potential because of a lack of opportunities presented to them to enhance these skills. The reason for this study was, therefore, to encourage Grade R children's sporting and academic success and to lessen the chance of developmental delays.

Sub aims of the current study were to determine whether gender and/or socioeconomic status play a role in the development of visual-motor integration of 5- 6-year-old children through a gross motor skills intervention.

Specific objectives

Objectives	**Method**
1. To determine the level of visual-motor integration of Grade R learners.	• Beery test of Visual Motor Integration (BTVMI-6).
2. To determine the level of gross motor ability of Grade R learners.	• Test of Gross Motor Development (TGMD).
3. To determine whether a gross motor skills intervention had a correlation with the visual-motor integration of Grade R learners.	• Compare the pre- and post-test scores.

HYPOTHESIS

Research hypothesis

The VMI skills of the neuro-typical Grade R learners, participating in the self-designed GMS intervention programme, will improve.

Alternative hypothesis

The VMI skills of the neuro-typical Grade R learners, participating in the self-designed GMS intervention programme, will not improve.

METHODOLOGY

Sample

Because of the existing relationships between the Stellenbosch Kinderkinetics at the Department of Sport Science, Stellenbosch University, and the participating schools, the sampling method was convenient. The four schools that participated were from the Somerset West (A), Franschhoek (B and C) and Jamestown (D) areas. These four schools differed in socio-economic backgrounds, represented by quintiles. Quintiles operate in a chronological order – Quintile 1 represents the lowest income schools and Quintile 5 represents the highest income schools. School A and B fall under Quintile 5, school C falls under Quintile 1 and School D falls under Quintile 2.

The participants were in Grade R and between the ages of 5 to 6 years (N=107). All the participants between these ages met the inclusion criteria to partake in the study. The participants, girls (n=49) and boys (n=58), were divided into an experimental (n=65) and control group (n=42). The experimental and control groups were split according to the school classes they attended. One class acted as the experimental group and the other class as the control group in schools that had only two Grade R classes. In schools that had three Grade R classes, two classes acted as the experimental group and one class as the control group. Please refer to Table 3.2 for the group sizes of the experimental and control groups of the different schools.

The experimental group from the respective schools participated one class at a time and the class was further divided into three groups to ensure optimal activity per child in the allocated 30-minute time slot once a week. The control group did not partake in the intervention and rather continued with a regular school day, generally consisting of play or singing during the intervention time-slot. Please refer to Table 3.2 for the group sizes of the division of the experimental and control groups of the different schools.

Inclusion and exclusion criteria

As previously indicated in Chapter 1, the inclusion and exclusion criteria for the current study are as follows: The participants were included if they attended one of the four participating schools, if they were in Grade R and between 5 and 6 years old. Participants could only participate if their parents/legal guardians had agreed to the study by signing consent forms and if the participants had signed assent forms (Children can write basic words by this age, but if they struggled, parents or teachers were requested to read the form aloud and help the children formulate their answers).

Participants were excluded if they did not have signed consent forms from their parents/legal guardians or who were absent from more than two sessions of the intervention. Children could not participate if they had been diagnosed with legal blindness (information was obtained from the teachers at the specific schools).

Place and duration of study

The pre- and post-evaluations, as well as the intervention, took place at the selected schools in areas allocated by the respective schools. These areas consisted of large, open spaces of paved areas, grassy fields or school halls. Evaluations also took place in these areas, as well as in the classroom. The entirety of the study lasted over a period of 13 weeks.

Statistical procedure

Professor Kidd from the Centre for Statistical Consultation at Stellenbosch University conducted the statistical analyses.

The current study made use of mixed model repeated measures ANOVA to investigate the effects of the intervention on the outcome measurements. In this model, the participants were included as random effect, and group (experimental, control), time (pre- to post-test) as fixed effects. The group*time interaction effect was specifically looked at to determine whether the change over time was the same or different between the groups. Relevant means and standard deviations were reported and a 5% ($p<0.05$) level was used as a guideline for significant results.

Ethical aspects

The Research Ethics Committee of Stellenbosch University (SU-HSD-004464) granted ethical clearance (Appendix A). The Western Cape Education Department provided permission (Appendix A) for the study to take place at the particular schools, and thereafter, the principals of the respective schools granted permission.

The parents and/or legal guardians of each participant signed a consent form in their language of preference. The consent form (Appendix B) explained in detail what the study aimed to achieve, the procedures of the study and what was required of the child and if they wished to participate. The children were also required to sign an assent form (Appendix B) that explained, in their language of preference and in a child-appropriate manner, what the study consisted of and what they could expect from it. This study did not force parents and/or legal guardians or children to comply with the participation requirements.

Participants were at all times supervised by the principal researcher; Kinderkineticists honours students and/or teachers during the testing and intervention sessions. All Kinderkineticists and Kinderkinetics honours students received police clearance and completed a Paediatrics First Aid course. The researcher is a qualified Kinderkineticist registered with the South African Professional Institute for Kinderkinetics (SAPIK) (01/016/09/1617/005).

PROCEDURES

Kinderkineticists and/or Kinderkinetics honour's students, adequately trained in the use of the selected tests, conducted all the tests. Over a period of two weeks, the participants were evaluated at their respective schools. The Test of Gross Motor Development 2nd edition (TGMD-2), was used to evaluate the participants in the first week, followed by the Beery test of Visual Motor Integration 6th edition (BVMI-6) in the second week.

The participants were evaluated with the TGMD-2 outdoors on a flat surface and evaluated with the BVMI-6 in the classrooms where every participant could sit at a desk.

During the pre- and post-evaluations, the evaluators were consistent and they were blinded as to whether evaluating the control or experimental group to ensure reliability and unbiased testing. Participants received testing explanations in the language of their choice.

Test of gross motor skills (TGMD-2)

The TGMD-2, a well-validated criterion- and norm-referenced motor evaluation tool, quantitatively evaluate the gross motor skills of children between the ages of three and 10 years and it requires the evaluator to observe the participants' performance (Robinson, 2010:591). The test consists of 12 different motor skills that are divided into two categories (each category consisting of six skills): locomotor (run, leap gallop, hop, jump and slide); and object control (catch, strike, bounce, overhand throw, underhand roll and kick) (Table 3.1). The locomotor subtest components require fluid and coordinated body movements as the participant moves from one place to another. The subtest components of object control require a participant to demonstrate coordinated throwing, catching and striking techniques – all of which require a sufficient level of hand-eye coordination. The Gross Motor Quotient (GMQ) is the best measure of an individual's overall gross motor ability. It is determined from the sum of the two subtest standard scores (Robinson, 2010:591).

The TGMD-2 is particularly useful in evaluating the effectiveness of a gross motor intervention programme by comparing the pre- and post-evaluations (Valentini, 2012:275).

It is also used to identify children who may be experiencing GMS developmental lags compared to their peers and to evaluate the success of individual GMS progress and development.

The test usually takes between 20 to 30 minutes to administer (Valentini, 2012:276). In order to perform the evaluations as quickly and efficiently as possible, evaluation conditions were arranged and organised before the arranged time of evaluation. All materials and equipment needed were readily available for each skill evaluated.

During evaluation, participants either wore laced-up school shoes, non-slip shoes or went barefoot as opposed to only wearing socks. Evaluation consisted of a verbal and practical demonstration. The participant received a trial run for each component evaluated on, followed by two more attempts where the evaluator would assess the performance of the child on the particular component. The trial score was not included in the overall capturing of the data; only the two attempts were recorded (Ulrich, 2000:10).

To save time during evaluations, the entire class was divided into smaller groups. Half of the class would complete the Locomotion test items, while the other half of the class completed the Object Manipulation test items. When both halves had finished the testing of one subtest, the groups switched testing stations. At least two evaluators were at each subtest. One evaluator would demonstrate and explain each skill separately, while the other evaluator made notes of the participant's performance of each skill on the testing booklet.

***TABLE 3.1*: KEY OUTCOME MEASUREMENTS AND THE SUB-SKILLS OF THE KEY OUTCOME MEASUREMENTS**

Key outcome measurements		**Sub-skills of key outcome measurements**
Gross Motor Quotient	Locomotion	Hop, jump, gallop, run, leap, slide
	Object control	Dribble, overarm throw, kick, strike a stationary ball, underhand roll, catch

Scoring

As the participant demonstrated different skills in the subtests, the evaluator recorded on the testing paper whether the child was competent or not. The evaluator recorded a 1 if the participant performed a test item correctly and a 0 if not. Once the whole test had been completed, the raw score for each subtest was derived from the sum of these skill scores. From the raw scores, standard scores were established from the tables at the back of the TGMD-2 testing manual. Standard scores allowed evaluators and the principal researcher to make comparisons across subtests. The gross motor quotient (GMQ) was converted to a standard score using a specific table in the TGMD-2 testing manual (Ulrich, 2000:12).

It is important to note that specific subskills of locomotion and object control have different maximum scores that a child can achieve. For locomotion, run, gallop, hop, jump and slide are scored out of a maximum of 8 points and leap is scored out of a maximum of 6 points. For object control, a strike is scored out of a maximum of 10 points, overhand throw, underhand roll, dribble and kick are scored out of a maximum of 8 points and a catch is scored out of a maximum of 6 points (Ulrich, 2000:12).

Reliability and validity

Reliability is the consistency with which a testing tool (TGMD-2) can estimate attributes of something or someone else. It is important that a test is reliable before using it to prevent false assumptions (Ulrich, 2000:29). Tests are valid when it is clear that they do and test what they are supposed to (Ulrich, 2000:35).

A study conducted by Hartman *et al*. (2010:148) that assessed the reliability and validity of TGMD-2 in children with visual impairments found the internal consistency of the test to be high. Hartman *et al*. (2010:149) found that the TGMD-2 is an appropriate tool to assess the gross motor skills of primary school children. Cronbach's alpha was used to determine the internal consistency of the locomotor and object control tests. The intra class correlation coefficient determined interrater, intra-rater and test-retest reliability. According to Hartman *et al*. (2010:149), the internal consistency, interrater, intra-rater and test-retest reliability was good. Valentini (2012:279) tested the validity and reliability of TGMD-2 for Brazilian children. Agreement among experts using the same testing tool must be high and positive in order to ensure valid and reliable results. Values higher than 0.8 represent sufficient concordance. Results from the interrater and intra-rater analyses all exceeded 0.8, thus confirming the appropriateness of using the TGMD-2 in terms of reliability and validity.

This specific study also emphasises the suitability of using the TGMD-2 for children from different cultural backgrounds (Valentini, 2012:279).

Beery test of visual motor integration (BTVMI-6)

The BTVMI-6 is a well researched and standardised test used by Kinderkineticists, Occupational Therapists, Physiotherapists and Educational Psychologists to assess the visual-motor integration (VMI) of children. The BTVMI-6 can be administered in individual or group settings. Visual Perception and Motor Coordination are additional tests used to statistically evaluate the relative contributions of visual and motor to VMI performance. It is extremely important to follow the correct sequence of testing: firstly, the Beery VMI; then Visual Perception; and lastly, Motor Coordination. This is because the exposure of one related test can affect the performance of another test and result in seriously affected norms.

In a classroom, the whole group can be assessed by the BTVMI-6 at once, as long as there are at least two evaluators present. There are three existing methods to testing the BTVMI-6: 1) two or more adults with 20+ children at one time; 2) one or two adults with 2+ children at one time; and 3) one adult with one child at one time.

To be able to finish assessment in the given time frames of the respective schools, method 1 was employed in the current study. This method is less expensive and less time consuming (it usually takes a maximum of 20 minutes). According to Beery and Beery (2010:20), method one is the most effective method. The BTVMI-6 manual provides the test instructions used. Evaluation was as follows for each school:

Visual-motor integration (VMI)

- Evaluation took place in a normal classroom setting, with participants sitting on a chair at a desk like the rest of their classmates. Each participant received a sharpened pencil and no eraser, as specified by the BTVMI-6 manual.
- Each participant received a booklet on his/her desk with the cover page on top and told not to open the booklet until the evaluator said so.
- The evaluator demonstrated with his or her own test booklet how the participants were to complete the test. The evaluator began at number seven, the vertical line, and copied the vertical line in the top square into the blank square directly below it.
- After the evaluator explained to the children to copy each form in the sequence as it appears in the booklet, all the participants could begin.
- Evaluation ended when it appeared that the whole group had finished. It does not usually take longer than 10 minutes.

Visual Perception

Smaller groups of participants formed part of this test. There were as many groups as there were testers available.

- Task 1: The evaluator asked participants to identify different body parts as specified on a sheet of paper. The participant only needed to point to the body part that the tester mentioned. Participants in a group who waited on their evaluation turn sat separately from the evaluator.
- Task 2: One at a time, participants needed to identify the outline of three different animals (as provided in the BTVMI-6 manual). The evaluator would name an animal and ask the participant to point at the animal on a sheet of paper. The other participants in the group waited separately until it was their turn.
- Task 3: Participants needed to identify the different body parts on a picture of a doll (as provided in the BTVMI-6 manual). Again, the other participants in the group waited separately from the evaluator and the participant under evaluation.
- Task 4: Participants sat down at their desks and were handed another test booklet. Evaluators explained to participants that they needed to identify from a list of shapes one that was an exact replica of the shape in the bold box. They had three minutes to complete the task.
- The evaluator did the first example with the participants in order to gauge whether they understood the task or not.
- Once everyone understood what was expected, the evaluator started his or her stopwatch and the participants could begin, identifying the matching shapes in the sequence that they appeared on the test booklet.

Motor Coordination

The participants remained in their same seats for the Motor Coordination evaluation, which lasted five minutes.

- The evaluator demonstrated on his or her test booklet how the participants needed to draw from dot to dot within the lines of each shape on the booklet. As with the previous two tests, the participants had to do it in the sequence as set out in the booklet.
- The participants were given time to practise on the allocated “practise shapes” on the top of the booklet. Once each participant had demonstrated an understanding of drawing between the lines of the shapes, the evaluator started his or her stopwatch and the participants began the test.

- After five minutes, all test booklets were collected.

Scoring

The principal researcher marked and scored all the BTVMI-6 papers to ensure consistency in the subjective scoring nature of the test. The principal researcher was also responsible for marking the subtests. The subtests do not allow much room for subjective marking, therefore, consistency was not as much of a concern.

The BTVMI-6, Visual Perception and Motor Coordination all score one point per item on the respective tests completed correctly. Each point per test is added-up in order to obtain the raw score. However, raw scores are of little use by themselves, and therefore, standard scores were derived by using a table provided in the BTVMI-6 manual. Standard scores allow the researcher to draw conclusions about each participant's performance. For example: very high; high; above average; average; below average; low; very low.

Reliability and validity

The BTVMI-6 has established validity and reliability. The validity of the BTVMI-6 was determined in a study focusing on using the BTVMI-6 in predicting achievement in pre-school, as well as first and second grade children (Klein, 2016:461). The test-retest reliability was suitably high enough to provide a future researcher with confidence that the BTVMI-6 is a reliable evaluation tool for pre-school children (Klein, 2016:461). A different study focused on interrater and test-retest reliability of the BTVMI-6 in schoolchildren and established that interrater correlations, as well as the test re-test reliability, were strong. Furthermore, because of to the high test-retest reliability across different age ranges, the BTVMI-6 is of value especially in studies that use the test to detect changes after an intervention (Campus *et al*., 2017:598).

Intervention

Theory and approach

To develop and implement the intervention programme of the current study, the Dynamic System Theory (DST) and a bottom-up approach was used. The DST states that movement develops using a multifaceted approach because of the interactions between the individual, the task and the environment. According to this theory, a child is a self-organising system and the interactions of many sub-systems determine and shape this system. Cognitive instructions, perceptions, motivation, physical fitness and practise all help to make up a new skill. However, if one variable is not in place in the bigger system, it may inhibit a child's performance, explaining how individual differences either inhibit or promote the desired performance (Antoniou *et al*., 2015:90). In the case of this intervention, the DST was appropriate because it encouraged the principal researcher to consider the influence of individual differences and constraints on motor performance. Once constraints were recognised, the researcher could manipulate and adjust the task or environment to promote the skill development of the individual. For example, participants had to jump on pictures laid out on the ground. However, the pictures slid on the surface when children landed on them, resulting in children struggling to perform the task optimally. Non-slip mats were then used to allow participants the best opportunity to master the task/skill at hand. The DST acts as a major source of inspiration to design a programme that altered constraints in physical activity tasks and skills within specific environments (Antoniou *et al*., 2015:91).

The DST encourages variability and recognises the importance of changing a task or environmental factor(s) in order to suit the needs of an individual. No child is the same as another child and this was evident in the current study. One participant might have been able to throw overhand at a moving target, whereas another participant might not have had the same level of hand-eye coordination. In this case, the task was varied slightly for the individual. Instead of a moving target, a stationary target replaced it. However, it is important to note that participants were encouraged to challenge themselves and progress to tasks that were more difficult once they demonstrated mastery of a skill.

The bottom-up approach operates under the premise that developing and enhancing a child's fundamental and underlying skills will improve his/her ability to perform a specific task as a whole. For example, if a child has difficulty with object control tasks, such as catching a ball, working on specific activities that use the same muscles and movements that underlie this task, will in theory improve this specific skill. The bottom-up approach encourages learning of a skill to convert that skill into real-world situations (Brown *et al*., 2011:46).

The current study aimed to develop skills in a creative style as opposed to teaching a skill in a straightforward manner. The bottom-up approach was particularly useful for the age group of the sample because participants learned skills bit by bit. The component parts of the skill were taught first and gradually the participants built up to the skill as a whole.

Gross motor skills intervention

The gross motor skills intervention began the week directly after the pre-test. The intervention consisted of a 30 to 40 minute session, once a week for duration of eight weeks.

The intervention session remained in the same place at the same time each week for each respective group.

Each session consisted of visually orientated tasks. These included a visually orientated warm-up, three activities and a cool down (See Appendix E). A visually orientated task simply means that all movements and skills taught made use of visual supports. Visual supports included pictures and equipment, demonstrations and imitations. For example, participants had to imitate a Kinderkineticist after he/she demonstrated a movement. Another example of visual supports was creating pathways from pictures/other materials and instructing children to follow the created trail.

The group performed the warm up and cool down together but were divided into three smaller groups (sub-groups) for the activities of each session. The principal researcher used a class list to split the group into sub-groups and each sub-group was assigned to a Kinderkineticist and/or Kinderkinetics honours student for the duration of the session. These sub-groups and their assigned Kinderkineticist and/or Kinderkinetics honours student did not change for the rest of the duration of the eight-week intervention.

***TABLE 3.2*: THE NUMBER OF CHILDREN PER GROUP PARTICIPATING IN THE INTERVENTION FOR EACH RESPECTIVE SCHOOL**

School	Group size	Sub-group size
A	N=±20 (x2)	n=±6 (x2)
B	N=±20 (x2)	n=±6 (x2)
C	N=±30	n=±10
D	N=±30	n=±10

Table 3.2 shows the experimental group size, as well as the size of the sub-groups during the sessions for each school. Schools A and B had two experimental groups, represented by "(x2)", whereas schools C and D had one experimental group. Experimental groups were the classes available at the respective schools.

Groups varied in size depending on the size of the classes per school. As can be seen in Table 3.2, school C and D consisted of more participants (n=±30), than the other four groups (n=±20) from school A and B. Therefore, sub-groups also varied in size (n=±10 / n=±6). Group sizes for the intervention were larger than the sample size mentioned under "sample" because children were not excluded from participating in the sessions if their consent forms had not been signed. Unsigned consent forms meant that children were only excluded from the pre- and post- evaluations.

This study made use of a group setting intervention. The design of the activities allowed small groups of children to be involved in activities at once. It meant that participants did not receive as much individual attention from the Kinderkineticists as a one-on-one session would allow. However, the objectives of the activities involved a group experience. It was essential to design activities that allowed more than one participant to be active at a time. For example, many activities required the involvement of all participants in order to carry materials or build structures. In order to learn successfully, participants had to communicate with their peers during the course of the activities.

Equipment

The researcher decided to use equipment (See Appendix D) that could be replicated by schools/caregivers/participants if they so wished to continue with the pre-schoolers skill development after the study. Expensive equipment or materials only found in a Kinderkinetics centre limit the opportunities for the participants to practise newly learned skills from the intervention. Therefore, the emphasis was on using recycled materials and objects found in everyday households. This included empty plastic milk bottles, newspaper cuttings, sheets of paper, toilet rolls, etc.

CHAPTER FOUR

RESULTS

INTRODUCTION

This chapter presents the visual, graphical and tabulated representations and summaries of results, captured over the course of the current study. The results will indicate whether an eight-week self-designed gross motor skill intervention programme had an effect on children's visual-motor integration (VMI) or not. Children's gross motor skills and visual-motor integration levels, pre- and post-intervention, were evaluated and recorded. This chapter will lay the foundation for discussion in Chapter Five.

Three main sections, namely: 1) demographic profiling; 2) gross motor skills; and 3) visual-motor integration, make up this chapter. In the sections to follow, the graphs will represent the demographic profiling of subjects (gender and socio-economic status [SES]), and the pre- and post-evaluation scores of gross motor skills (GMS), and visual-motor integration (VMI) between the experimental and control groups.

See Appendix C (p.108) for all tables mentioned in this chapter: Table 4.1; 4.2; 4.3 and 4.4.

DEMOGRAPHIC PROFILING

The following figures provide information of how many girls and boys participated in the study, as well as the SES of the participants' schools.

Figure 4.1 visually depicts the number of boys and girls who participated in this study. Out of the total number of children (N=107), 58 were boys and 49 were girls.

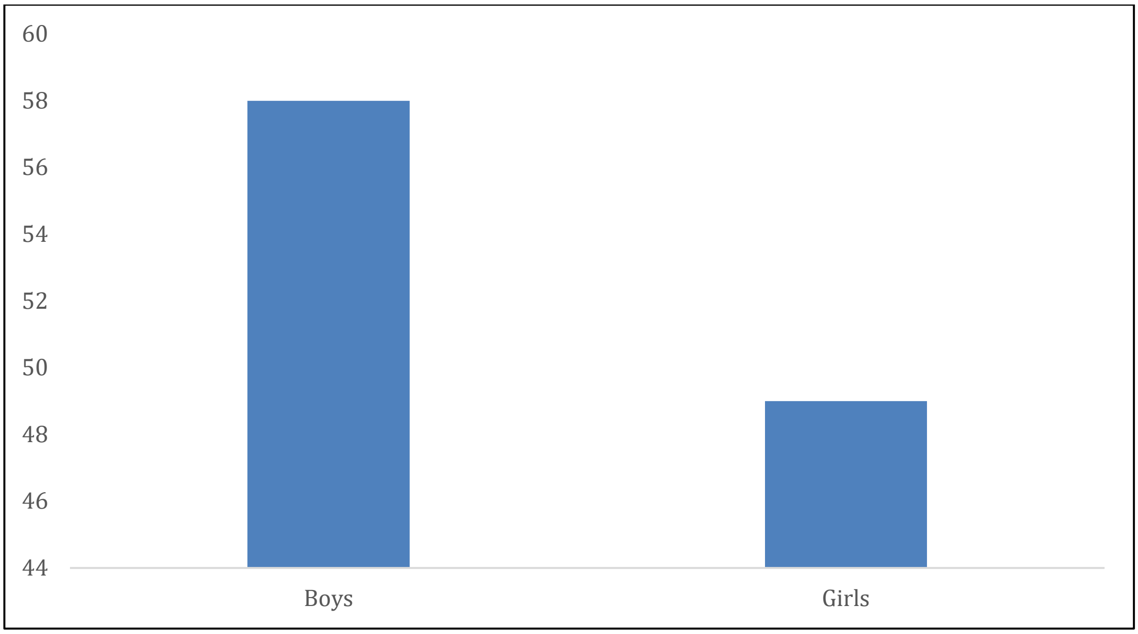

***FIGURE 4.1*: NUMBER OF BOYS AND GIRLS WHO PARTICIPATED IN THE INTERVENTION**

The number of participants from each school quintile features in Figure 4.2. This gives an indication of the diversity of the participant's socio-economic backgrounds. Quintiles operate in a chronological order – Quintile 1 represents the lowest income schools and Quintile 5 represents the highest income schools.

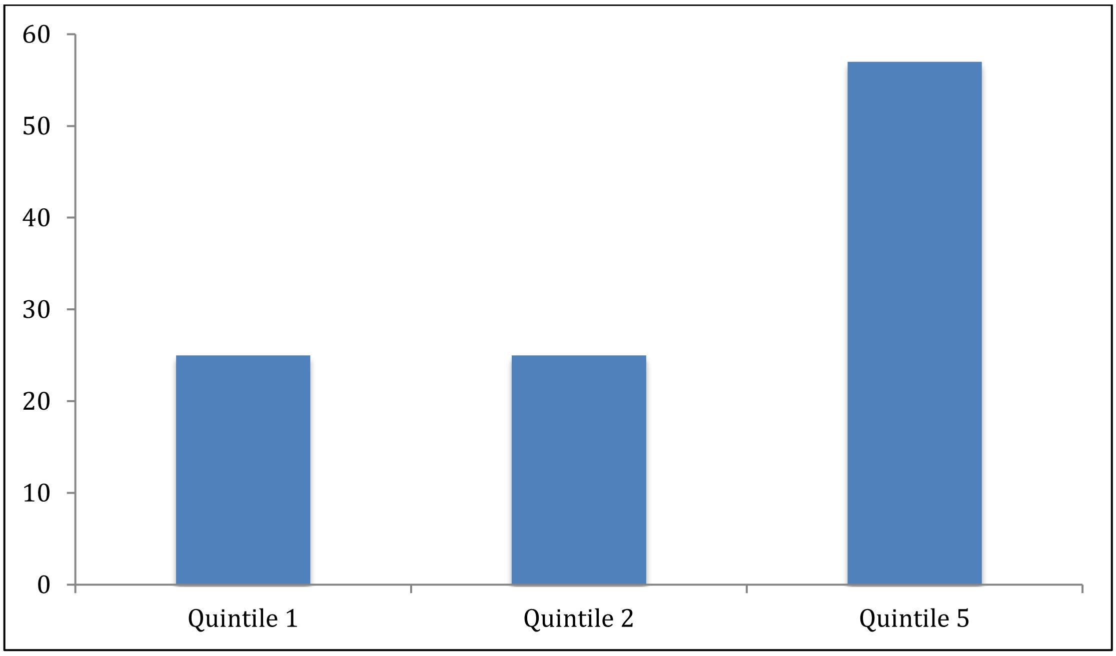

***FIGURE 4.2*: NUMBER OF PARTICIPANTS PER SCHOOL QUINTILE**

No statistical significant differences in GMS and VMI between the boys and girls and between the different schools were found. Therefore, the GMS and VMI results presented in the following sections will be for all experimental and control groups.

GROSS MOTOR SKILLS

The following figures and tables represent the GMS pre- and post-evaluation results obtained with the TGMD-2. The TGMD-2 evaluates 12 different motor skills divided into two categories, namely: 1) locomotion; and 2) object control. The Gross Motor Quotient (GMQ) score, a combination of a child's locomotor and object control abilities was also calculated (Ulrich, 2000).

Gross Motor Quotient (GMQ)

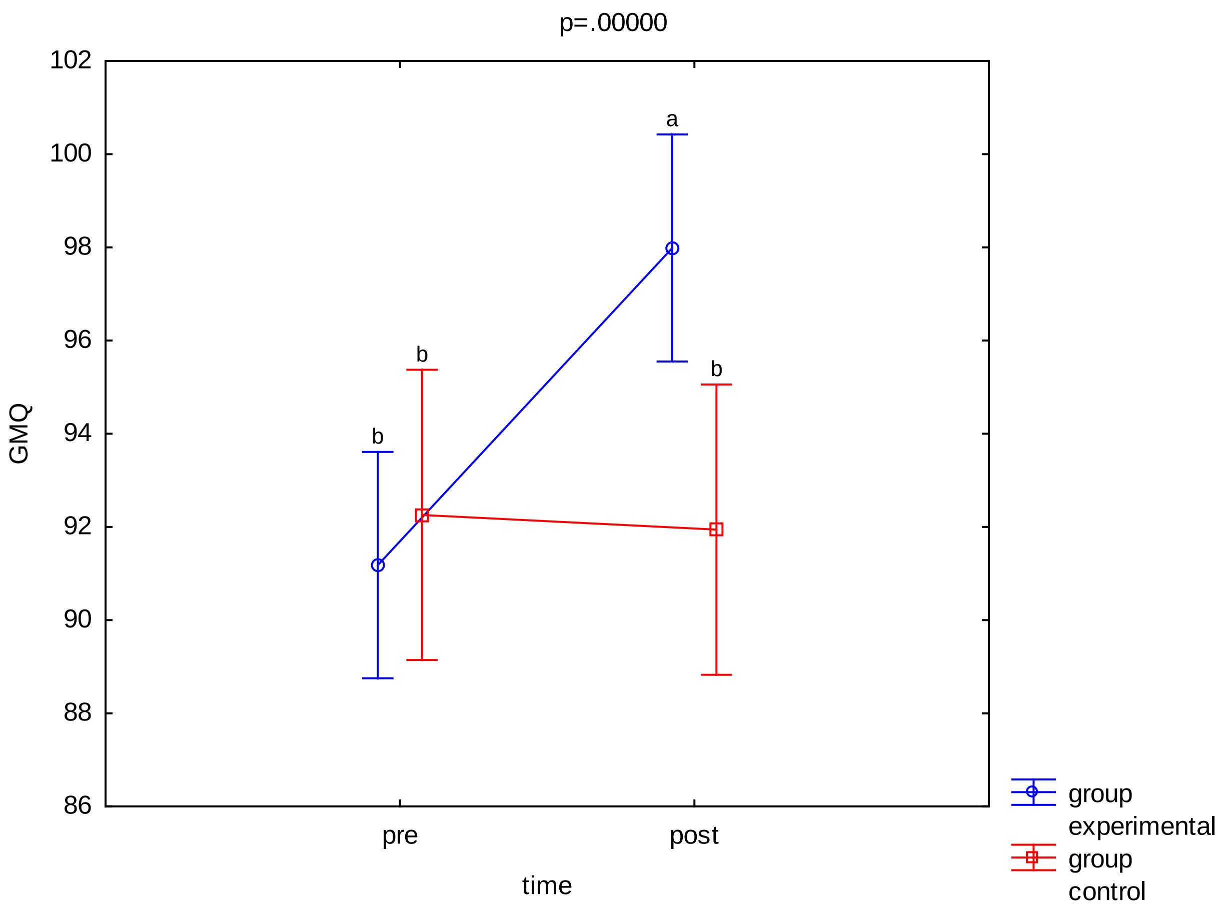

***FIGURE 4.3*: DIFFERENCE IN GMQ BETWEEN THE EXPERIMENTAL AND CONTROL GROUPS OVER TIME**

Figure 4.3 depicts the difference over time in GMQ scores for both the experimental and control groups. In Table 4.1 it is clear that the experimental group increased by 8.59 standard score points, whereas the control group decreased by 0.89 standard score points. This indicates that the intervention had a positive effect on the experimental group.

The average GMQ of the control group did not increase over time, whereas the average GMQ of the experimental group improved (Table 4.1). The difference between the groups over time was statistically significant (p=0.00). Figure 4.3 and Table 4.1 show that the experimental and control groups did not differ significantly pre-intervention (p=0.54). These visuals also disclose intragroup relations. The control group revealed an insignificant difference from pre- to post-intervention (p=0.39), conversely, the experimental group showed a significant difference from pre- to post-intervention (p=0.00).

Locomotion

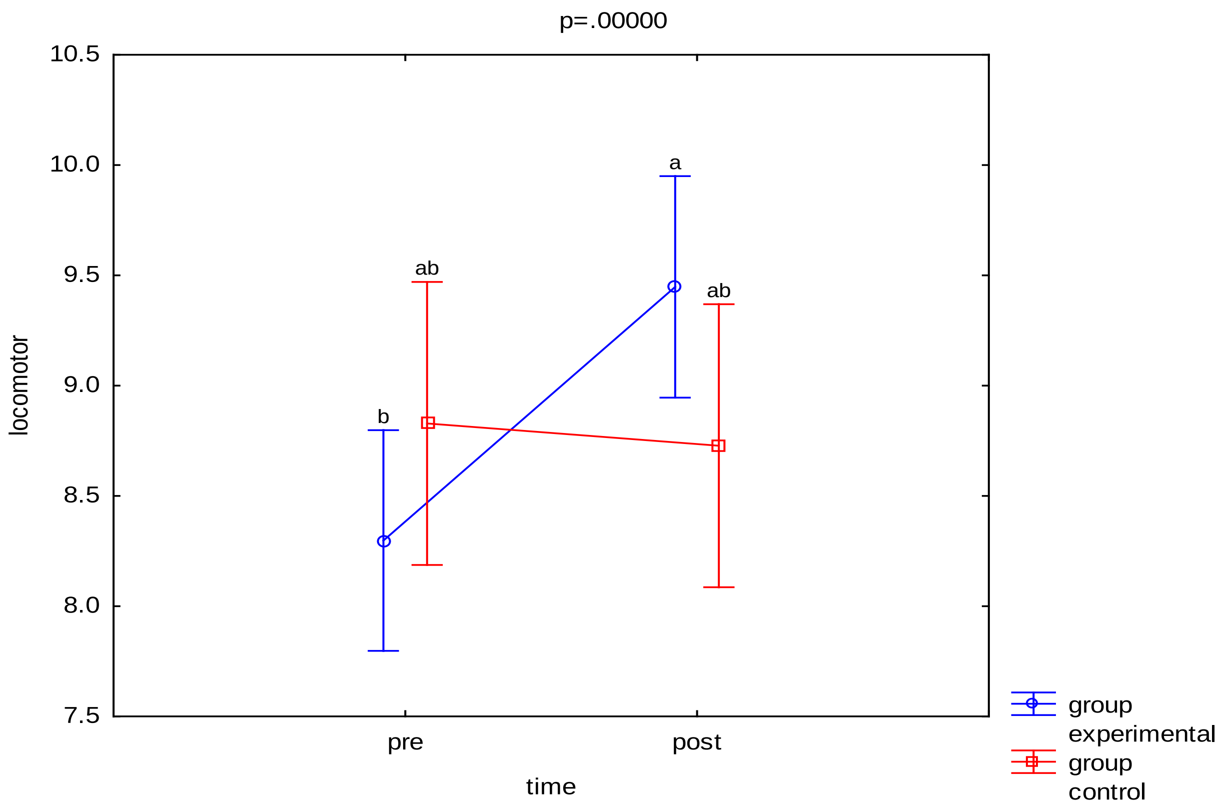

***FIGURE 4.4*:** **DIFFERENCE IN LOCOMOTOR SCORES BETWEEN THE EXPERIMENTAL AND CONTROL GROUPS OVER TIME**

The difference over time in locomotor scores for both the experimental and control groups feature in Figure 4.4. As indicated in Table 4.1 the experimental group increased by 1.17 standard score points, whereas the control group decreased by 0.1 standard score points. This indicates that the intervention had a positive effect on the experimental group.

Table 4. 1 shows that the control group's average locomotor scores decreased over time, whereas the experimental group's average locomotor scores increased. The difference between the groups over time was significant (p=0.00).

According to Figure 4.4 and Table 4.2 the experimental and control groups did not differ significantly pre-intervention (p=0.21). Intragroup relations are also shown in these graphical representations. The control group revealed an insignificant difference from pre-to post-intervention (p=0.6), conversely, the experimental groups showed a significant difference from pre- to post-intervention (p=0.00).

Hop

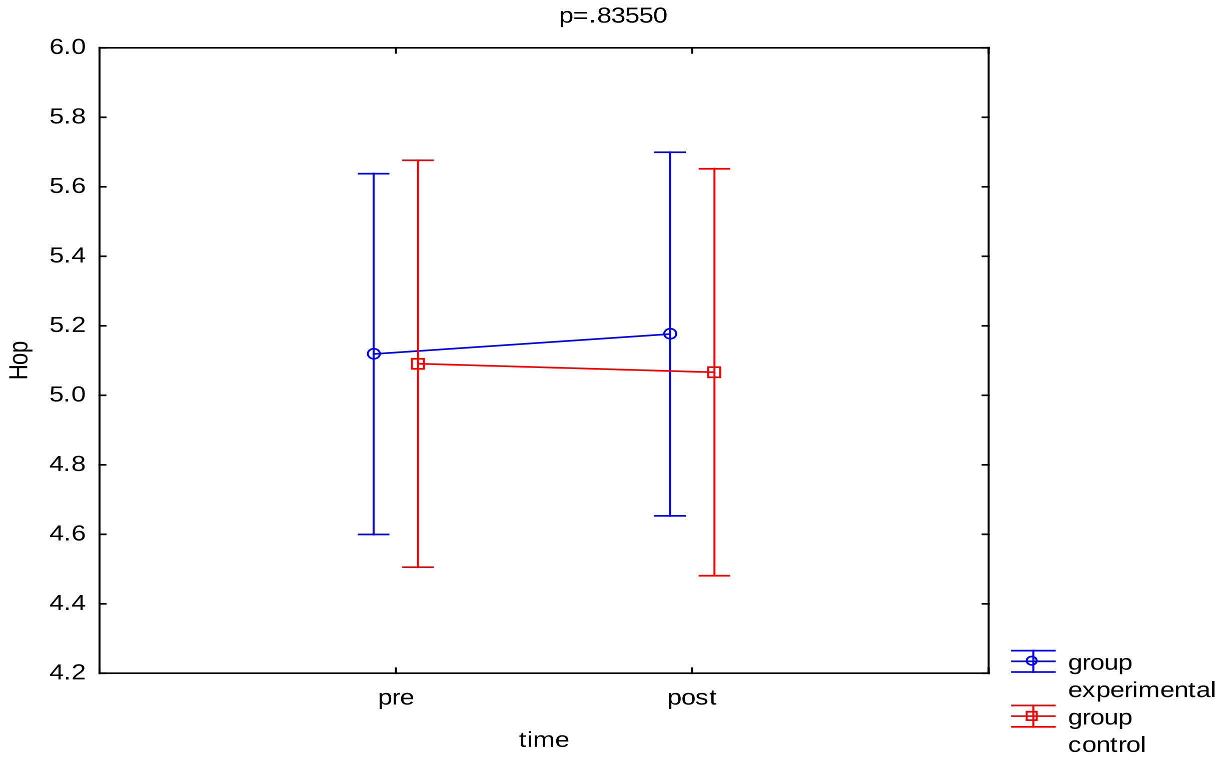

***FIGURE 4.5*: DIFFERENCE IN HOP SCORES BETWEEN THE EXPERIMENTAL AND CONTROL GROUPS OVER TIME**

Figure 4.5 shows the difference over time in hop scores for both the experimental and control groups . According to Table 4.1 the experimental group increased by 0.05 standard score points, whereas the control group decreased by 0.02 standard score points.

As depicted in Table 4.1 the control group's average hop scores decreased over time, whereas the experimental group's average hop scores increased. The change in time was so small for both groups, and therefore, there was no significant difference over time (p=0.84).

The experimental and control groups did not differ significantly pre-intervention (p=0.94) (Figure 4.5 & Table 4.2). Intragroup relations are also shown in these graphical representations. The control group and experimental group alike revealed no statistically significant differences from pre- to post-intervention (p=0.94; p=0.82 respectively).

Jump

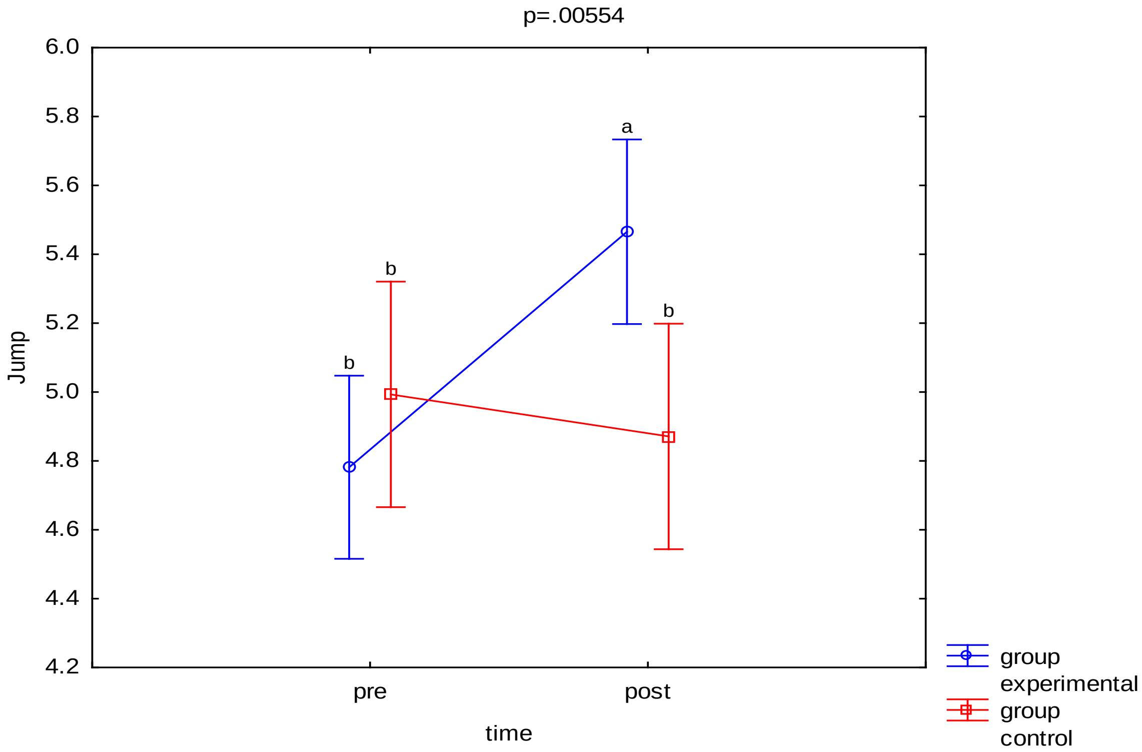

***FIGURE 4.6*: DIFFERENCE IN JUMP SCORES BETWEEN THE EXPERIMENTAL AND CONTROL GROUPS OVER TIME**

Figure 4.6 depicts the difference over time in the jump scores for both experimental and control groups. According to Table 4.1 the experimental group increased by 0.69 standard score points, whereas the control group decreased by 0.12 standard score points. This indicates that the intervention had a positive effect on the experimental group.

Table 4.1 shows that the control group's average jump scores decreased over time, whereas the experimental group's average jump scores increased. There was a significant difference between the two groups over time (p=0.01).

The experimental and control groups, according to Figure 4.6 and Table 4.2, did not differ significantly pre-intervention (p=0.32). Intragroup relations were also observed. The control group revealed an insignificant difference from pre- to post-intervention (p=0.59), conversely, the experimental group showed a significant improvement from pre- to post-intervention (p=0.00).

Gallop

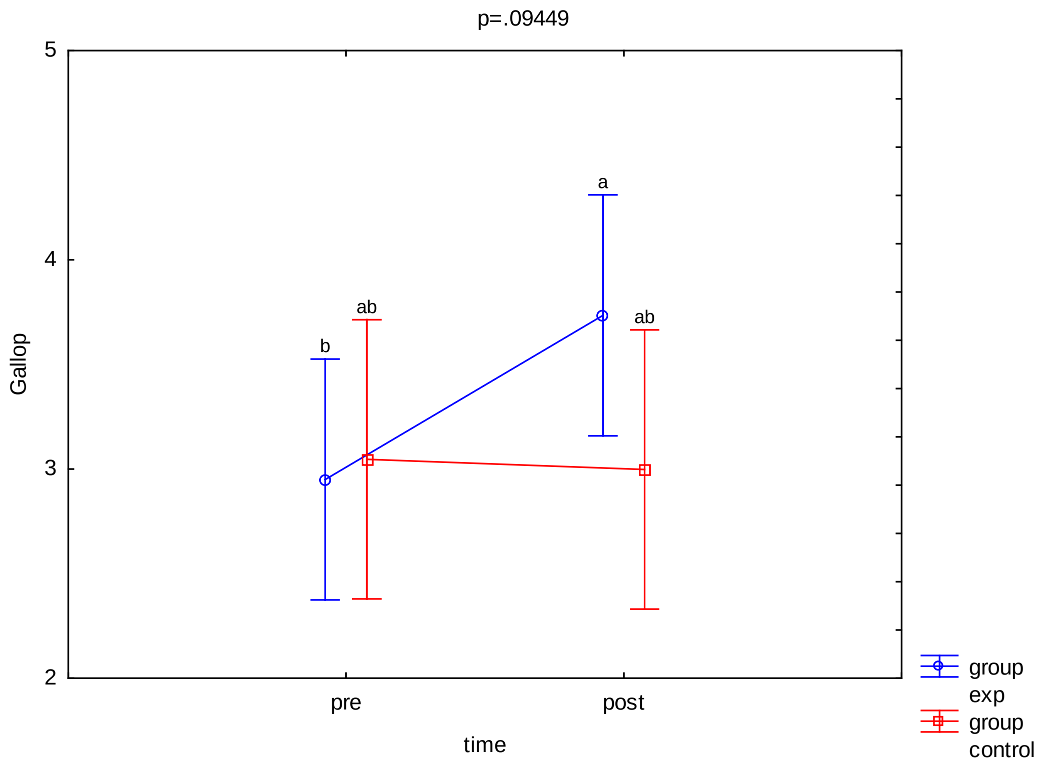

***FIGURE 4.7*: DIFFERENCE IN GALLOP SCORES BETWEEN THE EXPERIMENTAL AND CONTROL GROUPS OVER TIME**

In Figure 4.7 the difference over time in gallop scores for both the experimental and control groups is presented. According to Table 4.1 the experimental group increased by 0.79 standard score points, whereas the control group decreased by 0.05 standard score points. This indicates that the intervention had a positive effect on the experimental group.

The control group's average gallop scores decreased over time, whereas the experimental group's average jump scores increased (Table 4.1). There was no significant difference between the two groups over time (p=0.094).

Figure 4.7 and Table 4.2 indicate that the experimental and control groups did not differ significantly pre-intervention (p=0.83). Intragroup relations were also observed. The control group revealed no statistically significant difference from pre- to post-intervention (p=0.9), whereas the experimental group showed a significant improvement from pre- to post-intervention (p=0.01).

Run

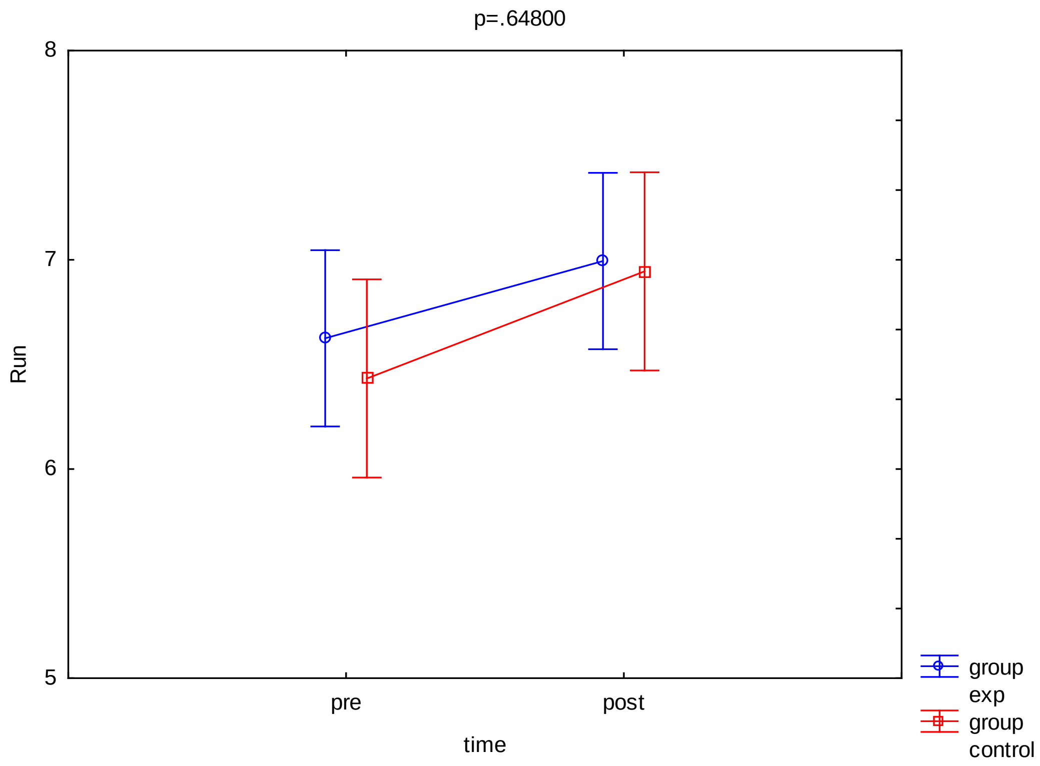

FIGURE 4.8**: DIFFERENCE IN RUN SCORES BETWEEN THE EXPERIMENTAL AND CONTROL GROUPS OVER TIME**

The difference over time in run scores for both the experimental and control groups feature in Figure 4.8. According to Table 4.1 the experimental group increased by 0.37 standard score points and the control group increased by 0.52 standard score points.

Table 4.1 shows that the experimental and control group's average run scores increased over time. There was no significant difference between the two groups over time (p=0.648).

According to Figure 4.8 and Table 4.2 the experimental and control groups did not differ significantly pre-intervention (p=0.55). Intragroup relations were also observed – the control group revealed a statistically significant difference from pre- to post-intervention (p=0.04), conversely, the experimental group showed no statistically significant improvement from pre- to post-intervention (p=0.06).

Leap

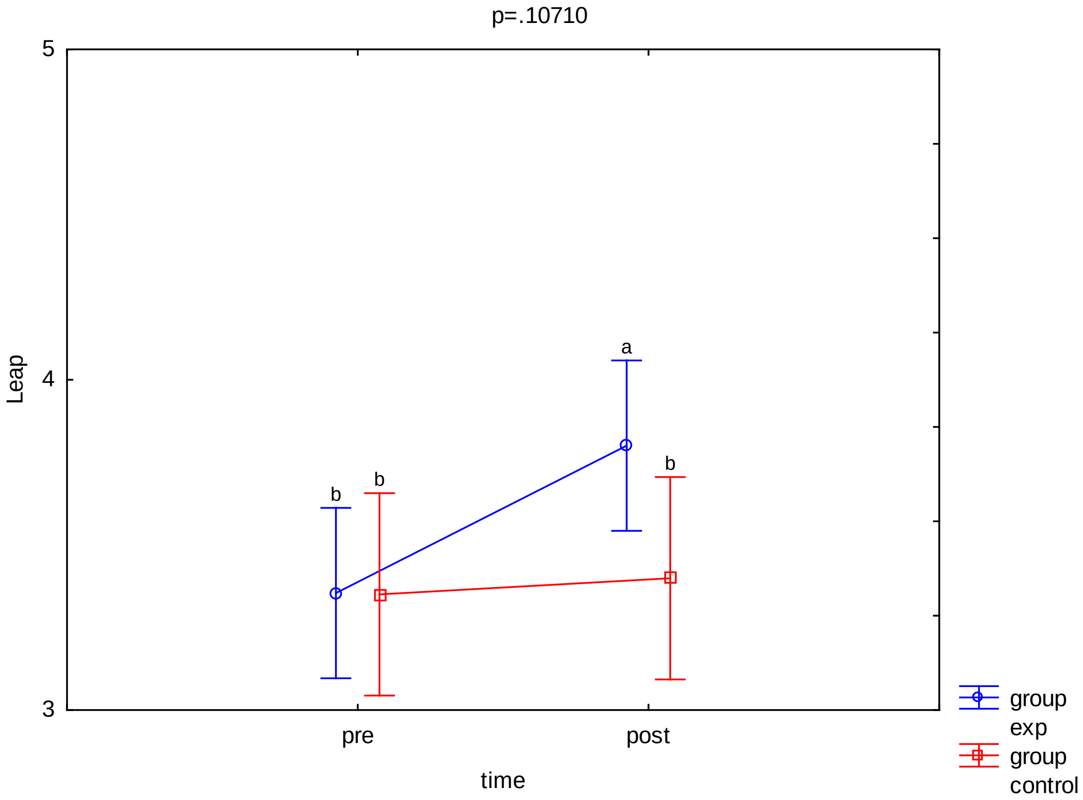

***FIGURE 4.9*: DIFFERENCE IN LEAP SCORES BETWEEN THE EXPERIMENTAL AND CONTROL GROUPS OVER TIME**

The difference over time in the leap scores for both experimental and control groups feature in Figure 4.9. The experimental group increased by 0.45 standard score points and the control group increased by 0.05 standard score points (Table 4.1).

Table 4. 1 shows that the experimental and control group's average leap scores increased over time, yet no significant difference between the two groups was reported (p=0.107).

According to Figure 4.9 and Table 4.2 the experimental and control groups did not differ significantly pre-intervention (p=0.98). Intragroup relations were also observed – the control group revealed an insignificant difference from pre- to post-intervention (p=0.8), whereas the experimental group showed a significant improvement from pre- to post-intervention (p=0.00).

Slide

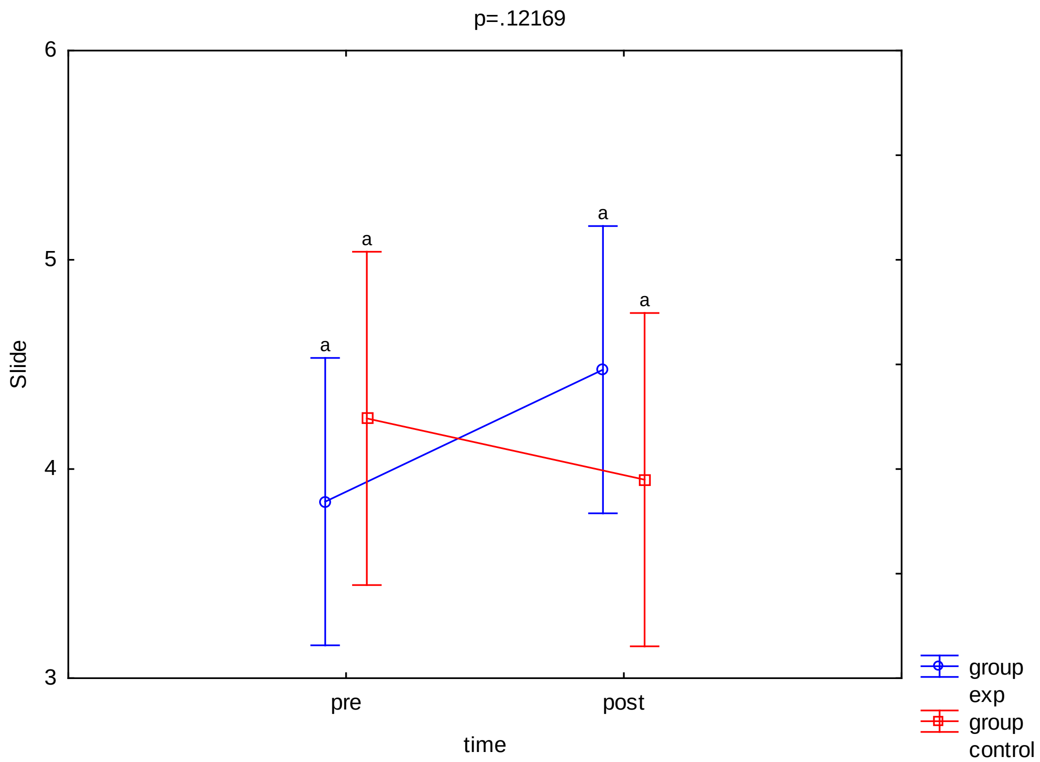

***FIGURE 4.10*: DIFFERENCE IN SLIDE SCORES BETWEEN THE EXPERIMENTAL AND CONTROL GROUPS OVER TIME**

Figure 4.10 presents the difference over time in the slide scores for both experimental and control groups. According to Table 4.1 the experimental group increased by 0.63 standard score points, whereas the control group decreased by 0.29 standard score points. This indicates that the intervention had a positive effect on the experimental group.

The control group's average slide scores decreased over time, whereas the experimental group's average slide scores increased (Table 4.1). However, there was a significant difference between the two groups over time (p=0.12).

Figure 4.10 and Table 4.2 indicate that the experimental and control groups did not differ significantly pre-intervention (p=0.46). Intragroup relations were also observed – the control group revealed no statistical significant difference from pre- to post-intervention (p=0.53) and the experimental group also showed no statistically significant difference from pre- to post-intervention (p=0.09).

Object control

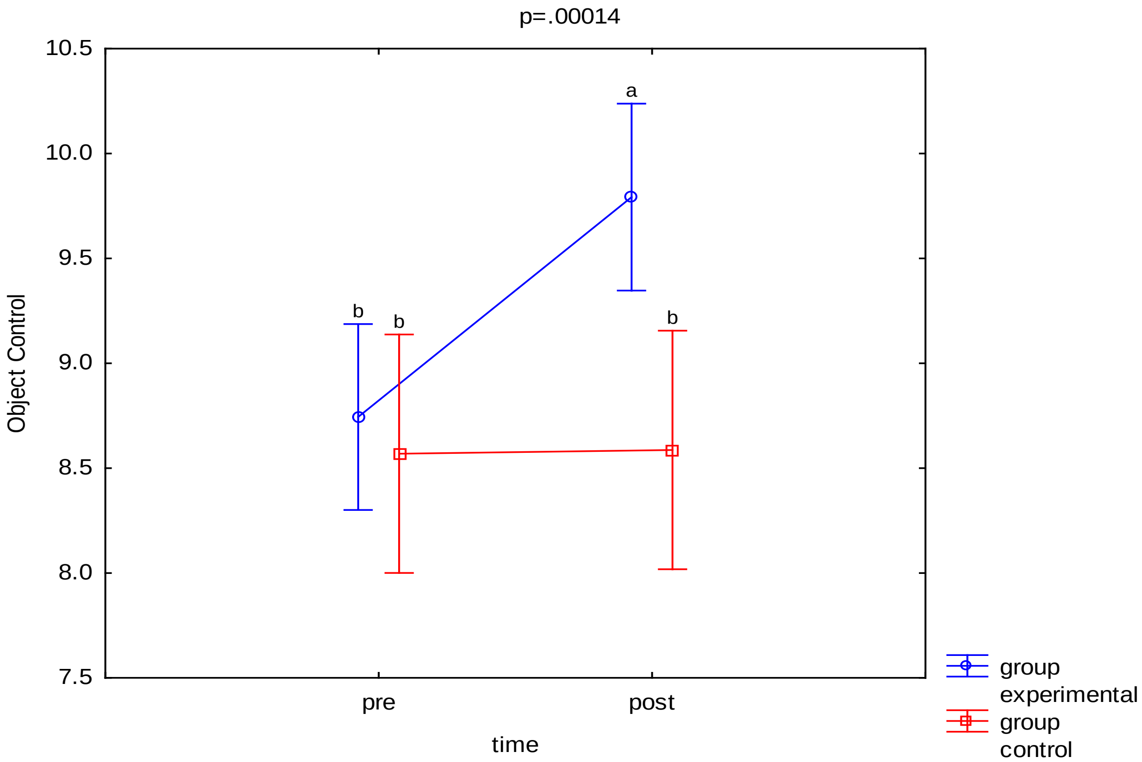

***FIGURE 4.11*: DIFFERENCE IN OBJECT CONTROL SCORES BETWEEN THE EXPERIMENTAL AND CONTROL GROUPS OVER TIME**

The difference over time in object control scores for both experimental and control groups features in Figure 4.11. According to Table 4.1, the experimental group increased by 1.05 standard score points and the control group increased by 0.02 standard score points. Therefore, the intervention had a positive effect on the experimental group.

The average object control scores of the control and experimental groups increased over time (Table 4.1). However, the increase of the control group was not statistically significant, whereas the experimental group (p=0.01) showed a statistically significant difference.

Figure 4.11 and Table 4.2 indicate that the experimental and control groups did not differ significantly pre-intervention (p=0.64). Intragroup relations reveal that there was an insignificant difference from pre- to post-intervention in the control group (p=0.93), whereas the experimental group showed a significant difference from pre- to post-intervention (p=0.00).

Dribble

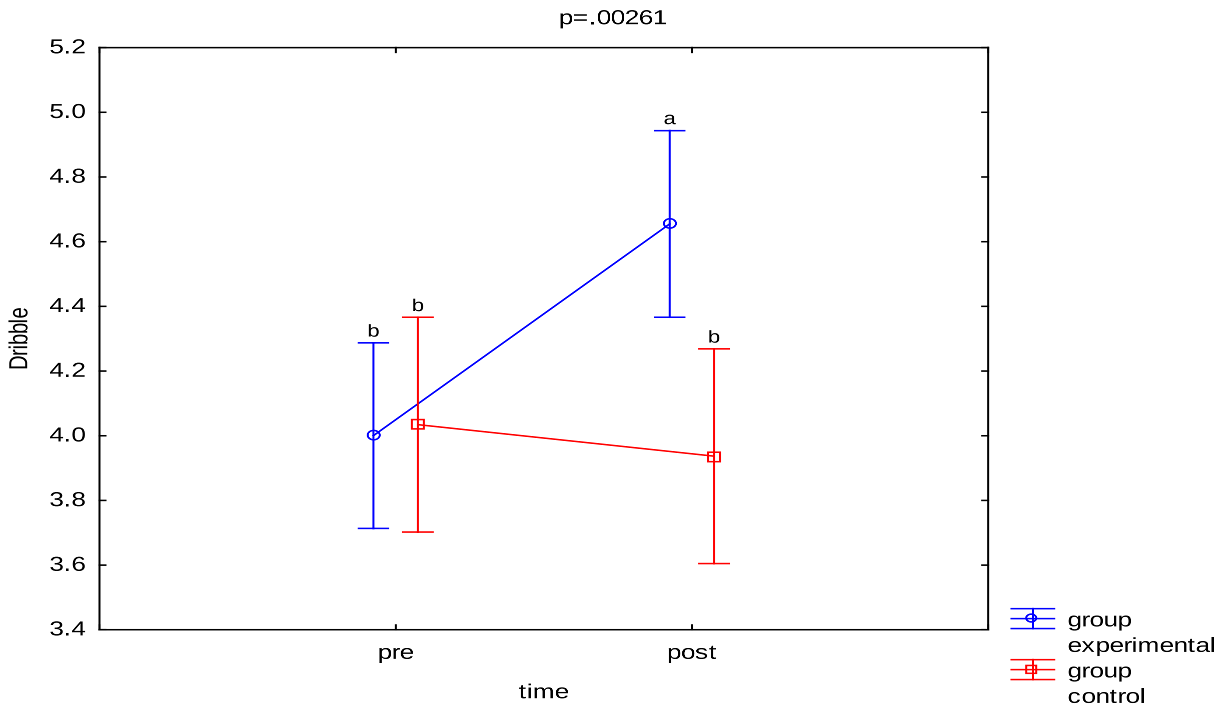

***FIGURE 4.12*: DIFFERENCE IN DRIBBLE SCORES BETWEEN THE EXPERIMENTAL AND CONTROL GROUPS OVER TIME**

The difference over time in dribble scores for both the experimental and control groups is shown in Figure 4.12. According to Table 4. the experimental group increased by 0.66

standard score points, whereas the control group decreased by 0.1 standard score points. This suggests that the intervention had a positive effect on the experimental group.

Table 4.1 displays that the control group's average dribble scores decreased over time, whereas the experimental group's average dribble scores increased. There was a significant difference (p=0.00) between the experimental and control groups over time.

According to Figure 4.12 and Table 4.2 the experimental and control groups did not differ significantly pre-intervention (p=0.88). Intragroup relations shows that there was an insignificant difference from pre- to post-intervention in the control group (p=0.61), whereas, the experimental groups showed a significant difference from pre- to post-intervention (p=0.00).

Overarm throw

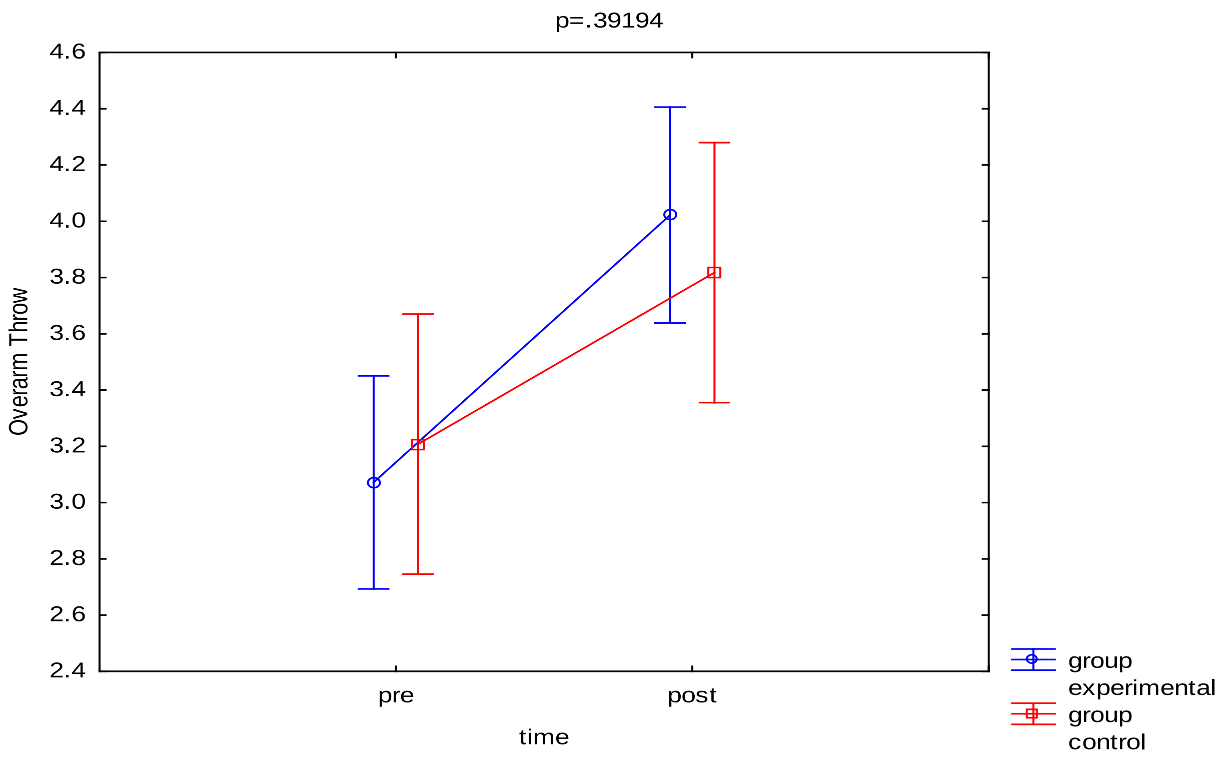

***FIGURE 4.13*: DIFFERENCE IN OVERARM THROW SCORES BETWEEN THE EXPERIMENTAL AND CONTROL GROUPS OVER TIME**

Figure 4.13 shows the differences over time in overarm throw scores for both the experimental and control groups. According to Table 4.1 the experimental groups increased by 0.95 standard score points and the control groups increased by 0.61 standard score points.

The average overarm throw scores of the control and the experimental groups increased over time (Table 4.1). The increases were so similar; therefore, there was no significant difference (p=0.39).

Figure 4.14 and Table 4.2 show that the experimental and control groups did not differ significantly pre-intervention (p=0.65). Intragroup relations reveal that there was, in fact, a significant difference from pre- to post-intervention in the control group (p=0.05), as well as a significant difference in the experimental group from pre- to post-intervention (p=0.00).

Kick

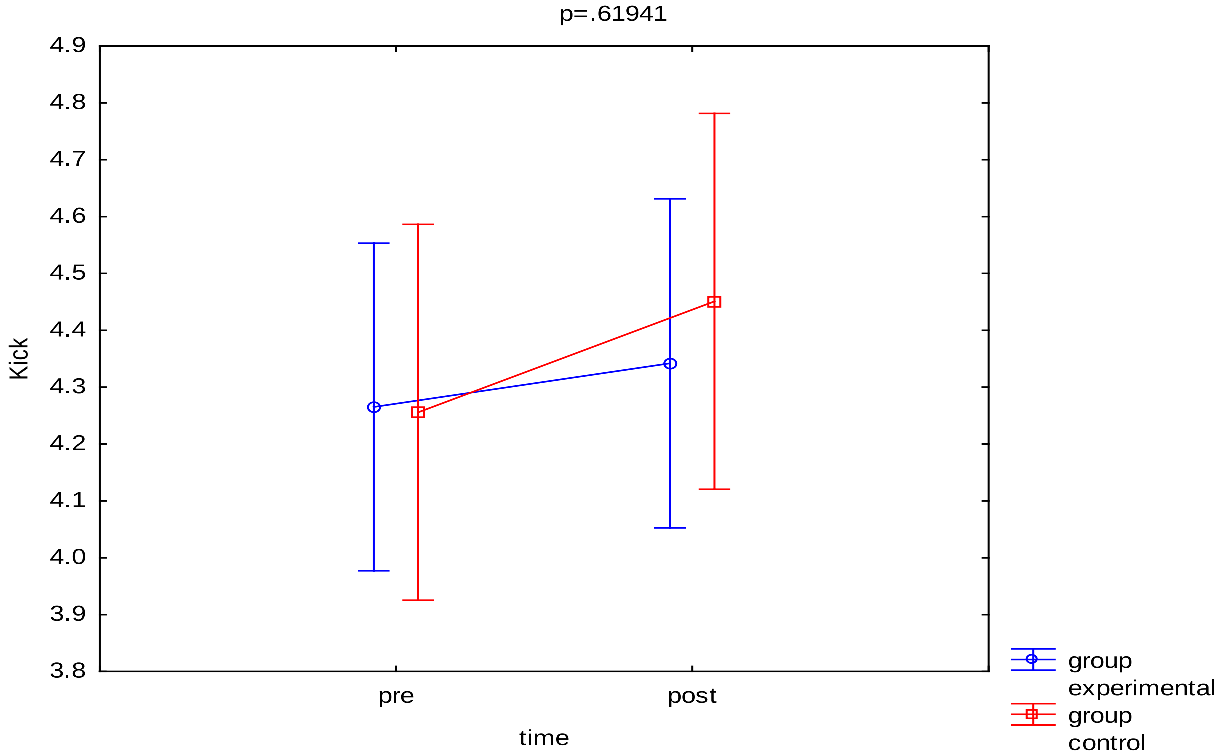

FIGURE 4.14 **DIFFERENCE IN KICK SCORES BETWEEN THE EXPERIMENTAL AND CONTROL GROUPS OVER TIME**

The difference over time in kick scores for both the experimental and control groups features in Figure 4.14. According to Table 4. 1 the experimental group increased by 0.09 standard score points and the control group by 0.19 standard score points. Whether or not the intervention had a positive effect on the experimental group's overarm throwing skills is not clear because of the greater increase in the control group's scores.

Table 4.1 points out that the average kick scores of the control and the experimental groups increased over time. The increases were so similar; therefore, there was no significant difference (p=0.62).

According to Figure 4.14 and Table 4.2 the experimental and control groups did not differ significantly pre-intervention (p=0.97). Intragroup relations reveal that there was an insignificant difference from pre- to post-intervention in the control group (p=0.3) and the experimental group (p=0.61).

Strike

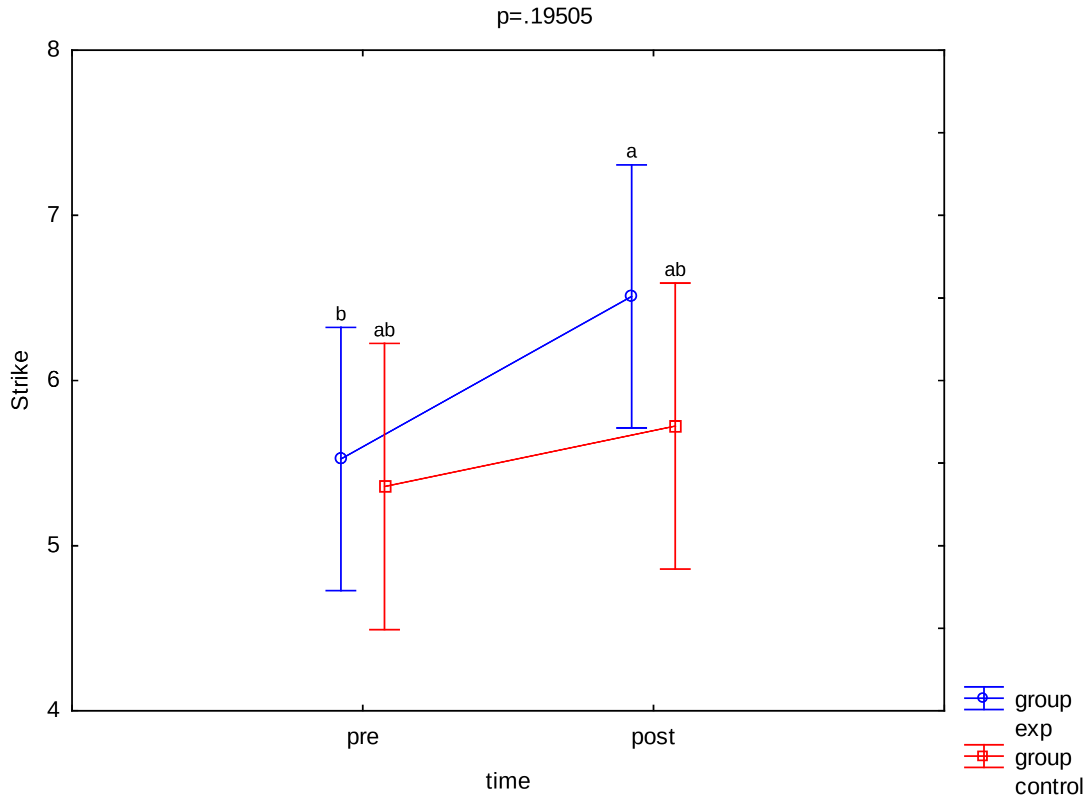

***FIGURE 4.15*: DIFFERENCE IN STRIKE SCORES BETWEEN THE EXPERIMENTAL AND CONTROL GROUPS OVER TIME**

Figure 4.15 depicts the difference over time in strike scores for both experimental and control groups. According to Table 4. 1 the experimental and control groups increased by 0.99 and 0.37 standard score points respectively.

The experimental and control group's average strike scores increased over time (Table 4.1). However, there was a significant difference over time (p=0.37).

Figure 4.15 and Table 4.2 indicates that the experimental and control groups did not differ significantly pre-intervention (p=0.78). Intragroup relations show that there was an insignificant difference from pre- to post-intervention in the control group (p=0.33), conversely, the experimental group showed a significant difference from pre- to post-intervention (p=0.00).

Underhand roll

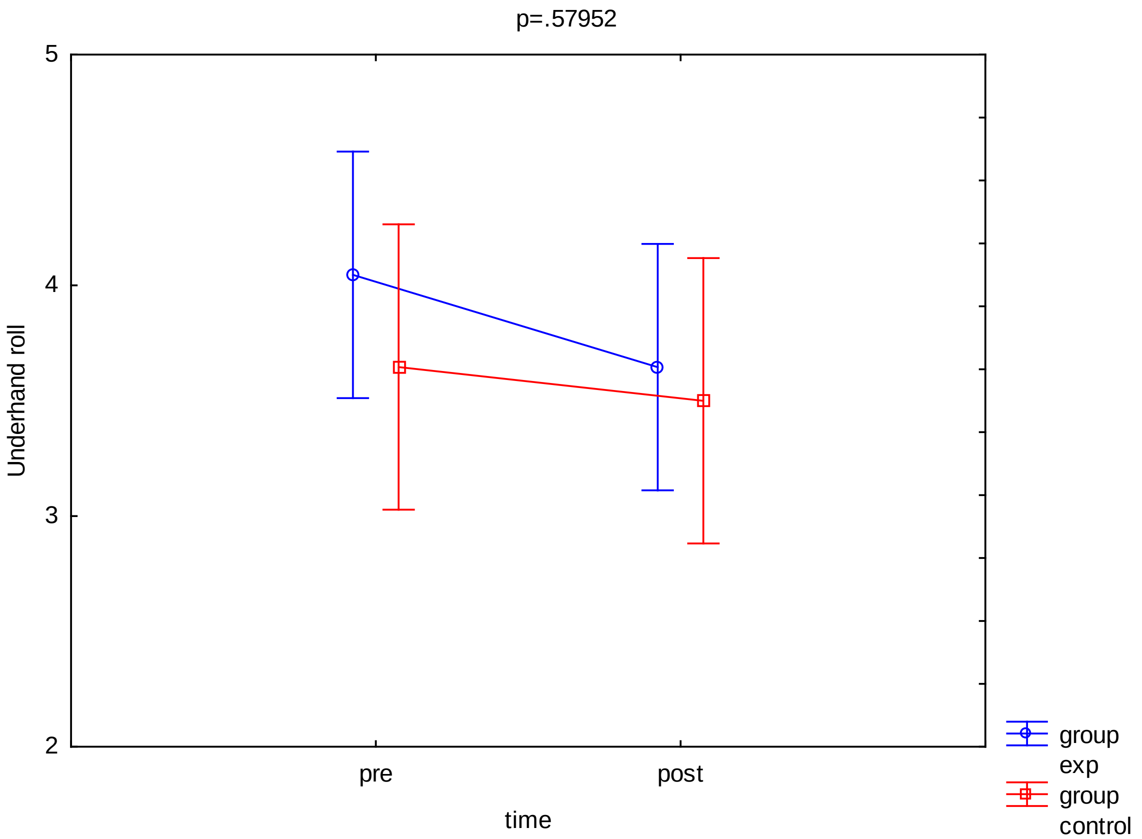

***FIGURE 4.16*: DIFFERENCE IN UNDERHAND ROLL SCORES BETWEEN THE EXPERIMENTAL AND CONTROL GROUPS OVER TIME**

The difference over time in underhand roll scores for both the experimental and control groups features in Figure 4.16. According to Table 4. 1 the experimental and control groups decreased by 0.4 and 0.14 standard score points respectively.

The experimental and control group's average underhand roll scores decreased over time (Table 4.1), however, there was no significant difference (p=0.58).

Figure 4.16 and Table 4.2 indicates that the experimental and control groups did not differ significantly pre-intervention (p=0.34). Intragroup relations show that there was an insignificant difference from pre- to post-intervention in the control group (p=0.68), as well as with the experimental group (p=0.16).

Catch

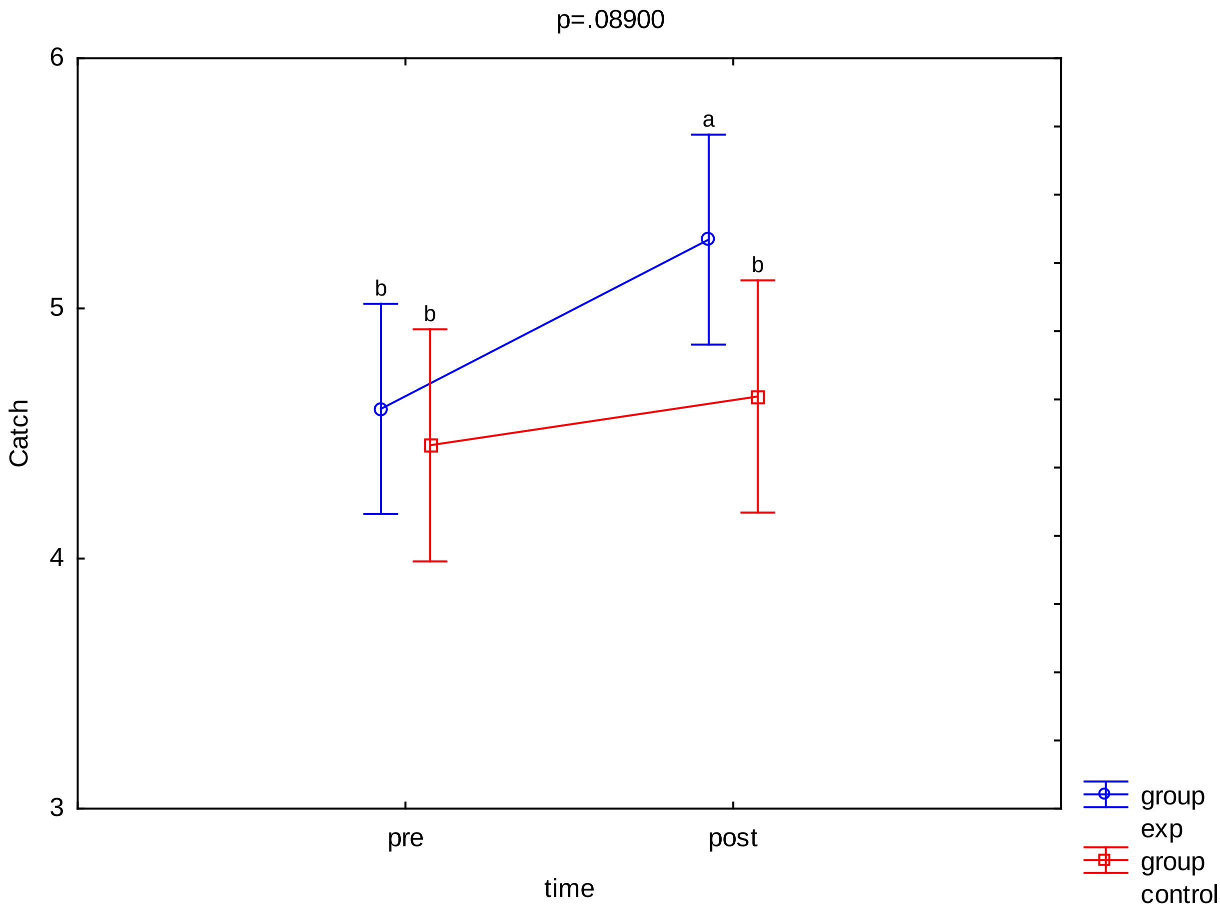

***FIGURE 4.17*: DIFFERENCE IN CATCH SCORES BETWEEN THE EXPERIMENTAL AND CONTROL GROUPS OVER TIME**

Figure 4.17 shows the difference over time in catch scores for both the experimental and control groups. According to Table 4.1 the experimental group increased by 0.67 standard score points and the control group increased by 0.2 standard score points.

The experimental and control group's average catch scores increased over time. There was a significant difference (p=0.00) between the experimental and control groups (Table 4.1).

Figure 4.17 and Table 4.2 indicates that the experimental and control groups did not differ significantly pre-intervention (p=0.65). Intragroup relations show that there was an insignificant difference from pre- to post-intervention in the control group (p=0.38), conversely, the experimental group showed a significant difference from pre- to post-intervention (p=0.00).

VISUAL-MOTOR INTEGRATION (VMI)

The figures presented in the sections below represent the VMI, Visual Perception and Motor Coordination of the pre- and post-evaluation results obtained by the BTVMI-6. Visual Perception and Motor Coordination are supplemental evaluations used to statistically determine the relative contributions of visual and motor to VMI performance. VMI is a measure of how well an individual can integrate visual stimuli into appropriate motor responses (Beery & Beery, 2010:20).

Visual-motor integration

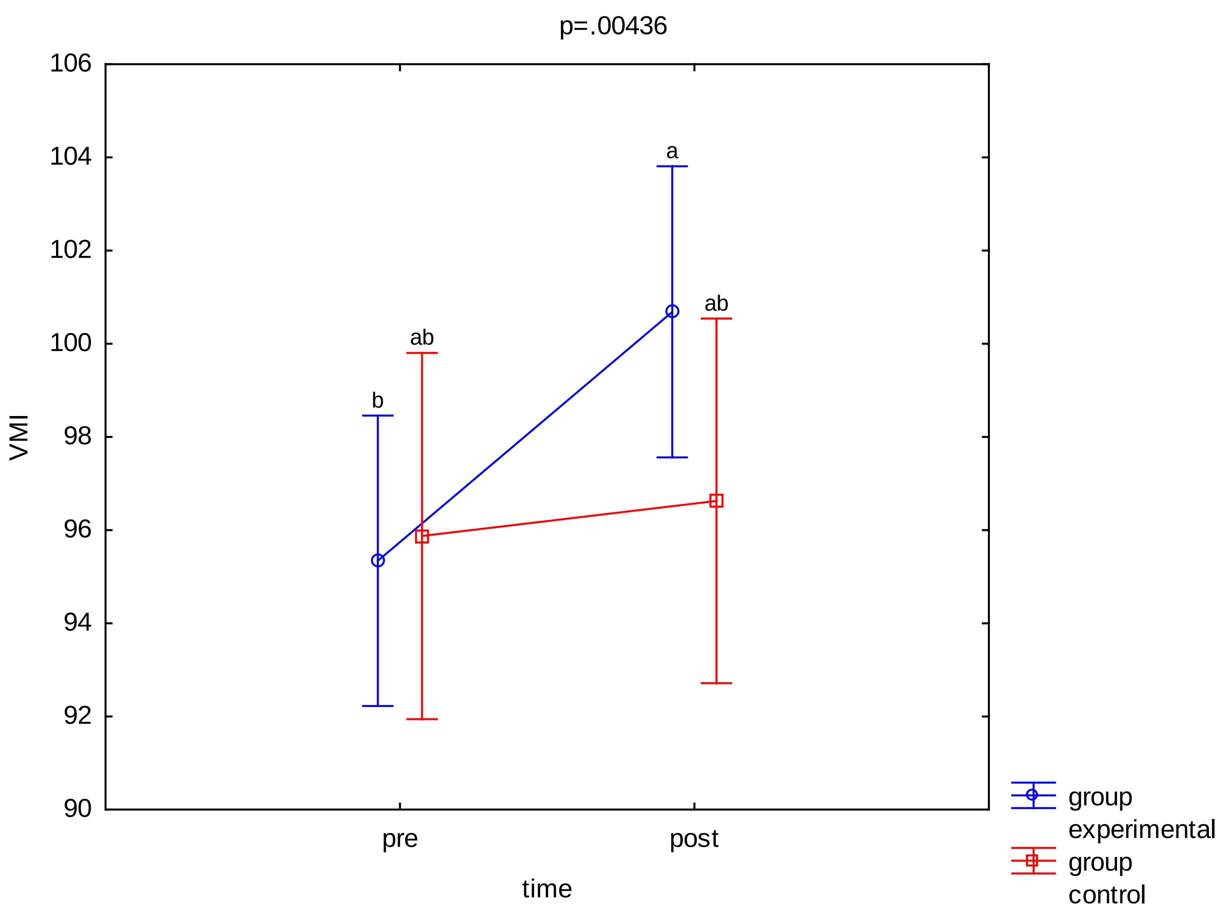

***FIGURE 4.18*: DIFFERENCE IN VMI SCORES BETWEEN THE EXPERIMENTAL AND CONTROL GROUPS OVER TIME**

The difference over time in VMI scores of both the experimental and control groups is presented in Figure 4.18. According to Table 4.3 the experimental group increased by 5.53 standard score points, whereas the control group only increased by 0.75 standard score points. This suggests that the intervention had more of a positive effect on the experimental group.

Table 4.3 indicates that the average VMI scores of the experimental and control groups increased over time. The increase of the control group was nominal in comparison to the increase of the experimental group, resulting in a significant difference ($p=<0.01$).

According to Figure 4.18 and Table 4.4 the experimental and control groups did not differ significantly pre-intervention ($p=0.84$). Intragroup relations reveal that there was an insignificant difference from pre- to post-intervention in the control group ($p=0.54$), whereas the experimental group showed a significant difference from pre- to post-intervention ($p=0.00$).

Visual perception

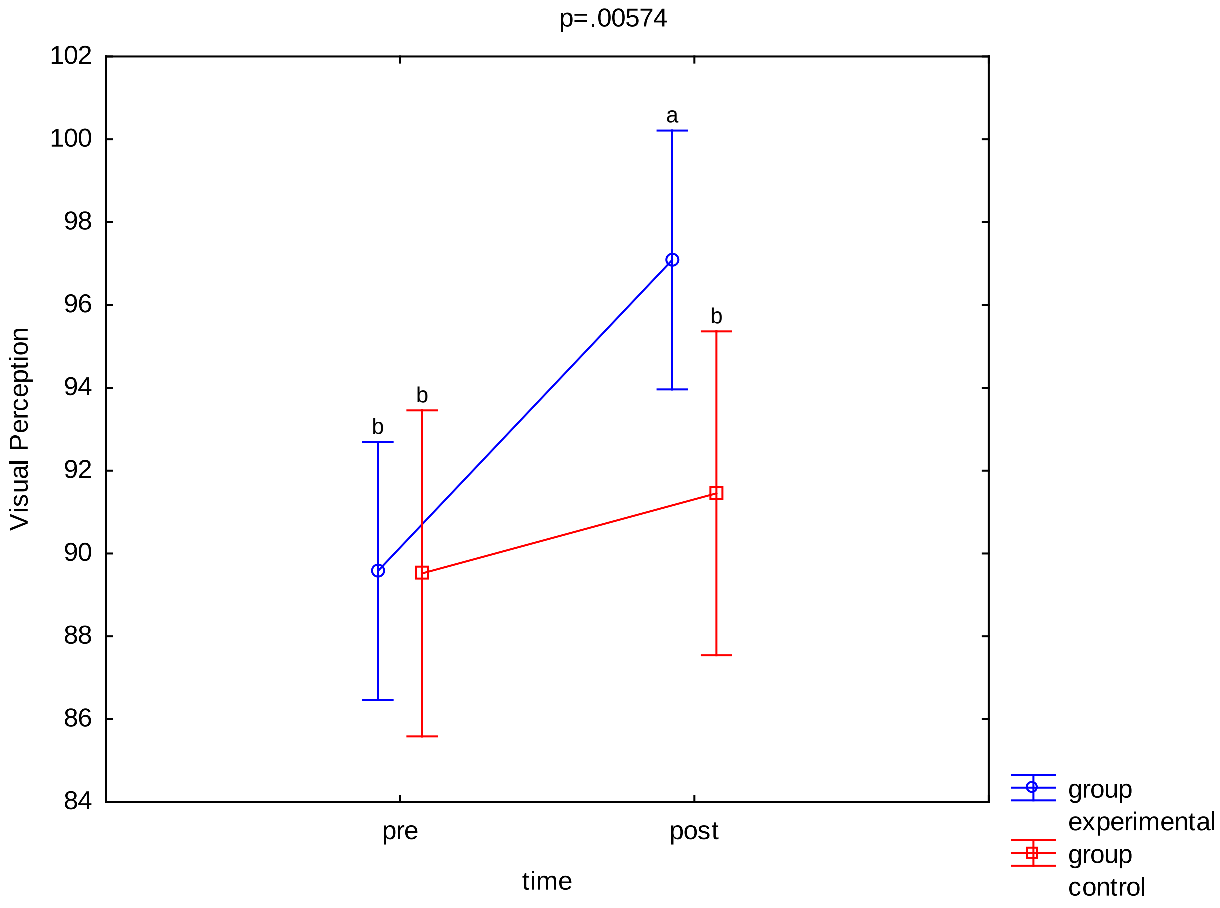

***FIGURE 4.19*: DIFFERENCE IN VISUAL PERCEPTUAL SCORES BETWEEN THE EXPERIMENTAL AND CONTROL GROUPS OVER TIME**

The difference over time in visual perceptual scores of both the experimental and control groups is shown in Figure 4.19 and Table 4.3 The experimental group increased by 7.51 standard score points, whereas the control group only increased by 1.93 standard score points. This proposes that the intervention had more of a positive effect on the experimental group.

Table 4.3 indicates that the average visual perceptual scores of the control and the experimental groups increased over time. The increase of the control group was nominal in comparison to the increase of the experimental group, resulting in a significant difference (p=0.01).

Figure 4.19 and Table 4.4 shows that the experimental and control groups did not differ significantly pre-intervention (p=0.98). Intragroup relations reveal that there was an insignificant difference from pre- to post-intervention in the control group (p=0.21), conversely, the experimental group showed a significant difference from pre- to post-intervention (p=0.00).

Motor coordination

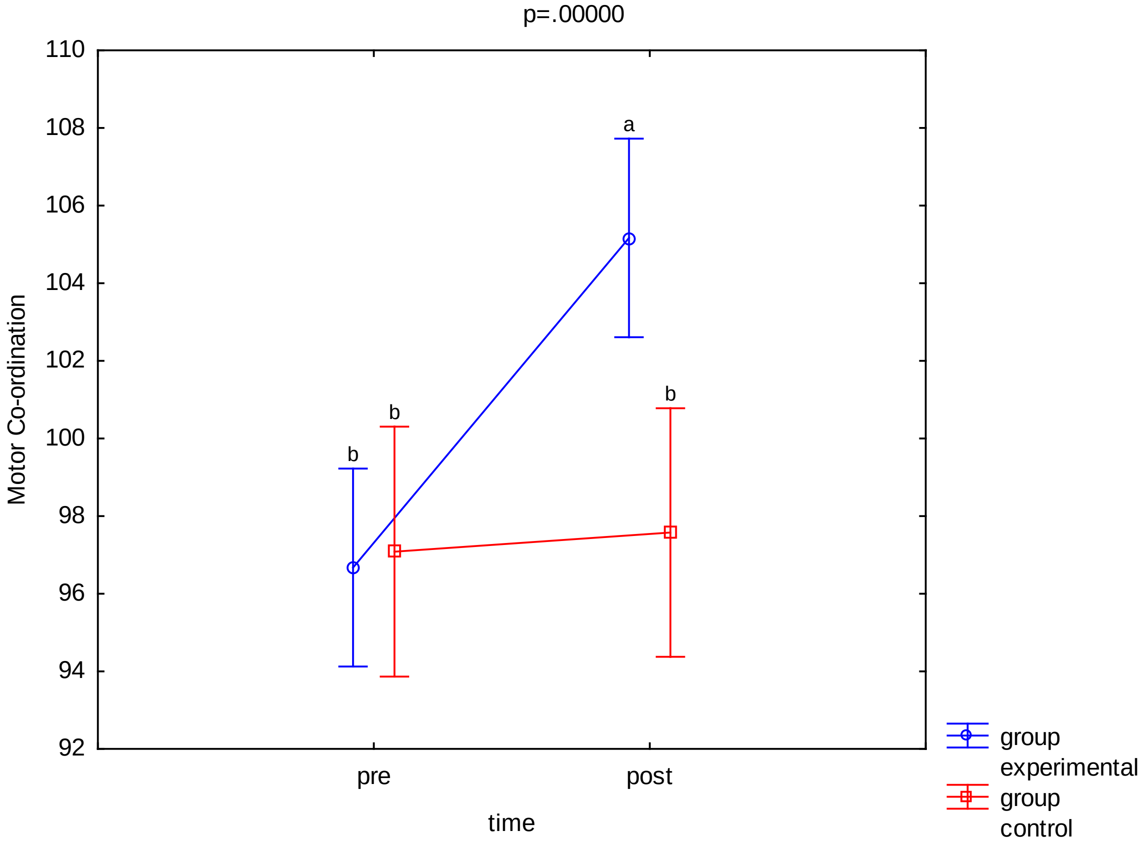

***FIGURE 4.20*: DIFFERENCE IN MOTOR COORDINATION SCORES BETWEEN THE EXPERIMENTAL AND CONTROL GROUPS OVER TIME**

The difference over time in motor coordination scores of both the experimental and control groups features in Figure 4.20 and Table 4.3. The experimental group increased by 8.49 standard score points, whereas the control group only increased by 1.23 standard score points. This proposes that the intervention had more of a positive effect on the experimental group.

Table 4.3 indicates that the average motor coordination scores of the experimental and control groups increased over time. The experimental group changed dramatically in comparison to the control group, rendering a significant difference (p=0.00).

According to Figure 4.20 and Table 4.4 the experimental and control groups did not differ significantly pre-intervention (p=0.85). Intragroup relations reveal that there was an insignificant difference from pre- to post-intervention in the control group (p=0.69), however, the experimental group showed a significant difference from pre- to post-intervention (p=0.00).

It is evident from these graphs that the experimental group improved after the intervention period. Despite the experimental and control group scoring differently in some of the pre-tests, the change in time for the experimental group was statically significant when compared to the control group.

CHAPTER FIVE

DISCUSSION OF RESULTS

INTRODUCTION

The primary outcome of this study was to determine the effect of a GMS intervention on pre-schoolers' VMI skills. This chapter aims to discuss the results reported in Chapter Four and compare these findings to previous research. Firstly, gender and socio-economic differences will be discussed followed by a separate discussion on the VMI and GMS results. The chapter concludes by linking GMS and VMI results. The control and experimental groups did not differ from each other during pre- evaluation before the intervention commenced. However, the post-evaluation revealed a significant difference between the control and experimental groups in all of the key outcome measurements.

GROSS MOTOR SKILLS

Locomotion and object control

A study by Branta and Goodway (2003:40) aimed to improve pre-school children's GMS through a motor skill intervention programme. The overall results of the intervention showed a significant improvement in the children's locomotion and object control abilities (Branta & Goodway, 2003:41). Logan *et al*. (2012) conducted a meta-analysis of the effectiveness of motor skill interventions on children between the ages of four and 12 years. Logan and associates found a significant effect of motor interventions on the GMS development of children. Children's locomotion and object control abilities both improved after motor skill interventions; therefore, motor skill interventions are effective in improving the GMS of children (Logan *et al*., 2012:305).

Another study conducted by Rudisill and Valentini (2004:330) examined the effects of a motor skill intervention on the motor skill development of children with and without disabilities. The results after the 12-week intervention demonstrated significant improvements in motor skill performance, both locomotion and object control skills, in both groups of children (Rudisill & Valentini, 2004:330).

Bellows *et al*. (2017:998) conducted a longitudinal study investigating the effect of motor skill development in low-income pre-schoolers. Bellows and colleagues employed a community-based intervention and the pre- and post-evaluation results differed significantly from each other. The pre-schoolers partaking in the intervention demonstrated significant changes in overall GMS development, in both locomotion and object control skills (Bellows *et al*., 2017:997).

Deli and Zachopoulou (2006:15) found similar results in their study. After participating in the motor skills intervention programme of 16 weeks, the experimental group of pre-school children improved significantly. Deli and Zachopoulou (2006:15) looked deeper into which specific locomotor skills improved after the intervention - running, hopping, leaping and horizontal jumping improved significantly. Messier and Pagani (2012:98) reviewed 11 different FMS school-based interventions in pre-school children. The interventions were implemented one to four times a week for a period of 13 weeks. Results showed a significant improvement in multiple GMS, such as running, jumping, throwing and catching.

The current study is in line with previous research because the pre-school children who participated in the eight-week GMS intervention programme displayed significant increases in their overall gross motor ability, locomotion and object control skills. In the current study, the overall locomotor skill and the jump, gallop and leap sub-skills improved significantly. This corresponds with the results of the study conducted by Deli and Zachopoulou (2006:15). When children are physically active, their motor skill competence improves because of active movement (An & Figueroa, 2017:140). Therefore, children's GMS competence improved after the current study's intervention period because children were receiving extra physical activity time each week, and as a result, they were involved in more GMS practise.

VISUAL MOTOR INTEGRATION

Visual Perception and Motor Coordination

The current study showed a significant improvement in the VMI abilities of the experimental group compared to the control group, post intervention. The intervention focused on improving children's GMS, incorporating visual cues and visually guided movements. The experimental group's overall VMI improved, as well as the separate components of VMI, namely visual perception and motor coordination. These results support the notion that the components of VMI do not operate separately. Visual perception and motor coordination depend on each other and co-develop as the body works out surroundings and how to respond to stimuli (Gallese, 2016:128).

Dankert *et al*. (2003:542) conducted a study where pre-school children's VMI skills were determined pre- and post- intervention. Pre- and post-evaluation results revealed an improvement in the experimental group. They concluded that interventions that make use of VMI abilities effectively improve VMI skills in pre-school children. This result was also true for the supplemental evaluations, visual perception and motor coordination, that improved post-intervention (Dankert *et al*., 2003:548).

In a study conducted by Bonifacci (2004:157), pre-school children's motor abilities were compared to their VMI abilities. It was found that better motor abilities are linked to better VMI abilities; therefore, as one of these skills improves it can positively influence other skills. However, it was noted that no significant difference was found regarding an increase in visual perceptual abilities when VMI and motor skills increased (Bonifacci, 2004:163).

Desoete *et al*. (2012:498) examined the effects of Grade 2 children's mathematical skills on their motor and visual abilities. The results showed a positive correlation between mathematical skills and visual and motor skills. Children who had mathematical learning difficulties scored lower in VMI skills when compared to children who did not have mathematical learning difficulties. The results also indicated that the children's visual perceptual and motor coordination abilities directly related to the level of their VMI skills (Desoete *et al*., 2012:490).

GROSS MOTOR SKILLS AND VISUAL MOTOR INTEGRATION

Relationship between overall GMS and VMI

As stated previously, the purpose of the current study was to determine whether a GMS intervention could improve the VMI of 5- to 6-year-old children. The research hypothesis (H_1) of the current study regarding VMI improvement of the experimental group was supported. The findings of the current study demonstrated that children in the experimental group performed significantly better on VMI skills post-intervention than the control group. This is in line with previous research. Previous research has shown that the co-development of skills, such as GMS and VMI, allows each specific skill to develop optimally. GMS allows a child to navigate his or her surroundings and VMI allows a child to make sense of and manipulate objects in his or her surroundings (Hamilton & Liu, 2017:228). The current study demonstrated that in developing GMS – locomotion and object control skills, VMI skills – visual perception and motor coordination, developed as a result.

Most studies focusing on improving children's VMI skills make use of occupational therapy interventions, and therefore, concentrate more on activities involving fine motor skills (Daly *et al*., 2003:459; Dankert *et al*., 2003:542; Chan *et al*., 2015:7). No previous studies can be compared precisely to the current study because there are no replicas of an intervention such as the one used in this study. The current study made use of a predominantly GMS intervention to improve the VMI abilities of pre-school children. The results concluded that the improvement of GMS competence in pre-schoolers positively affects their VMI skills.

A similar, study conducted by Goodwin (2015:52), examined the effects of a GMS intervention on the perceptual skills and school readiness of Grade R learners. Goodwin found no difference between the experimental and control groups in VMI skills pre- and post-intervention. Interestingly, both experimental and control groups improved in their overall GMS after the intervention period (Goodwin, 2015:69).

In the current study, overall GMS (locomotion and object control skills) of the Grade R learners improved from pre- to post- evaluation, whereas the control group did not significantly improve. The same was true for the overall VMI skills (Visual Perceptual and Motor Coordination skills). Both Goodwin's (2015:49) intervention and the current study's intervention consisted of a gross motor intervention focusing primarily on VMI. However, Goodwin's intervention incorporated more varying focus areas that aimed to improve not only specifically GMS and VMI skills of children, but also academic skills (Goodwin, 2015:49). The greater variance in focus areas could be reason for children's improvement not being as significant in Goodwin's study. The current study, however, focused solely on GMS and VMI skills of pre-school children, and therefore, all the activities aimed to improve only these areas of the children's development. The specificity of the activities of this study could have resulted in a greater overall improvement post-intervention.

Relationship between locomotion and VMI

Studies have not extensively examined the relationship between locomotion and VMI in children; however, a study by Drew and Marigold (2017:2) found a positive relationship in VMI and locomotion abilities after participants completed visually guided locomotion activities. The relationship between the two skills was measured by recording neuronal activity, while participants walked on a treadmill and also had to step over or navigate around various obstacles. Proving that there is a link in brain activity between locomotion and VMI when an individual is performing either of the skills supports the findings of the current study.

Locomotion skills improved significantly overall in the experimental group compared to the control group of the current study, specifically regarding jump, gallop and leap. VMI scores of the experimental group also improved significantly compared to the control group, therefore, the improvement of locomotion skills have a positive influence on VMI abilities of pre-school children. This could be because the fact that the same areas of the brain are activated when performing locomotor movements and when using the visual-motor system (Drew & Marigold, 2017:2).

Relationship between object control and VMI

Previous research has shown a positive relationship between object control skills and VMI. VMI contributes to making sense of objects and deciding the most accurate and efficient way to manipulate specific objects in an environment (Hamilton & Liu, 2017:229). The current study supports this notion because the experimental group improved significantly compared to the control group in both VMI and object control skills post-intervention.

Object control skills improved significantly overall in the experimental group compared to the control group of the current study, with specific regard to dribble, strike and catch. The same was true for VMI, visual perception and motor coordination. VMI processes occur in the posterior parietal and premotor cortex where specific parts of the body are selected to perform different movements. This area of the brain is activated when relations are formed between objects and motor movements that act upon the specific objects (Carlson *et al*., 2013:516). Object control skills activate this area of the brain because these skills require appropriate motor responses to act on specific objects. Skills such as dribbling, striking and catching a ball require the body to form relations between motor responses and objects.

The results of the current study show that handling and manipulating objects improves the visual-motor system and vice versa, therefore, the two skills co-develop (Morley *et al*., 2017:228).

DEMOGRAPHIC PROFILING

Gender differences in gross motor skills

The research of Bonoti *et al*. (2014:14) indicated that gender differences in overall GMS do not usually differ between boys and girls between the ages of 5 and 6 years. However, recent research has noted gender differences in locomotion and object control abilities of 5- to 6-year-old children (Barnett *et al*., 2016:488). In the study conducted by Barnett *et al*. (2016:488) on pre-school children's GMS abilities determined by the =TGMD-2, girls outperformed their male peers in locomotion scores; however, the opposite was true for object control scores. In a fundamental movement skills (FMS) intervention conducted by Bardid *et al*. *(*2017:185), both boys and girls, between the ages of 5 and 6 years, did not differ in locomotion and object control pre-evaluation results. However, post-evaluation results favoured the improvement of locomotion and object control scores for the boys. According to Bonoti *et al*. (2014:14) the majority of studies examining the difference in GMS abilities between boys and girls in Grade R, did not produce significant differences. The study of Bonoti and colleagues did not show a significant difference in GMS between boys and girls. The gender differences in gross motor ability were normally too small to report on at this age (Bonoti *et al*., 2014:15).

The current study showed no statistically significant difference between boys and girls and their GMS abilities. This is in line with previous research suggesting that GMS capabilities of children in pre-school do not differ significantly between boys and girls (Morley *et al*., 2015:150).

Gender differences in visual-motor Integration

Maki *et al*. (2001:665) reported that girls have a tendency to outperform boys in VMI skills. VMI skills refer to fine motor movements involving small muscle groups, mainly finger-hand movements such as holding a pencil (Elferink-Gemser *et al*., 2015:697). These skills are highly associated with the ability to write and read (Dankert *et al*., 2003:542). The study executed by Maki *et al*. (2001:644) showed that pre-school girls outperformed their male counterparts regarding the mechanics of handwriting. It is interesting to note that these studies contradict the findings of the current study, because girls did not perform better than boys in the Beery Test of Visual Motor Integration.

Amundson and Weil (1994:982) conducted a study that examined the VMI performance of pre-school children and concluded that there were no gender differences in the performance on the VMI test. Other studies, such as the longitudinal studies performed by Lotz and Loxton (2005:54) and Lachance and Mazzocco (2006:195), found that the difference in VMI skills between boys and girls were too insignificant to report.

Goodwin (2015:54) conducted a study examining the effects of gross motor skills on the perceptual-motor skills of pre-school children. According to her results, VMI performance between boys and girls rendered no significant difference.

According to Albulena *et al*. (2016:280) insufficient research has been conducted on gender differences regarding visual perception and/or motor coordination. Albulena and colleagues found no significant difference between boys and girls in the visual perceptual abilities of children up to the age of 14 years.

The current study found no significant gender differences for the achievement in VMI, visual perceptual and motor coordination skills both pre- and post-intervention. The reason for this could be attributed to the use of only one test battery used to examine the VMI levels of the pre-school children. More importantly, gender differences in neurotypical children's motor skills development between the ages of 5 and 6 years are, generally speaking, inconsequential (Bonoti *et al*., 2014: 13).

Socio-economic differences in Gross motor Skills

The relationship between socio-economic status (SES) and the motor proficiency of children is less commonly reported than the relationship between gender and motor proficiency of children (Morley *et al*., 2015:150). GMS relies on the opportunities a child has to grow and mature his/her motor abilities (Kambas & Venetsanou, 2010:319). Children from low socio-economic backgrounds are often outperformed by children from high socio-economic backgrounds regarding performance on motor development test batteries (Lejarraga *et al*., 2002:47; Kambas & Venetsanou, 2010:320), because children from low socio-economic backgrounds often do not have access to the same education, skills and training as children from higher income backgrounds (Morley *et al*., 2015:150).

More studies tend to focus on the relationship between SES and fine motor skills rather than on GMS (Dawson *et al*., 2008:668). According to De Barros *et al*. (2003:1678) low SES in pre-school children, strongly relate to poorer fine motor abilities; however, SES does not seem to affect children's GMS as profoundly. Yet, the study conducted by Bellows *et al*. (2017:997), aimed at determining the status of GMS performance in low-income pre-schoolers, found a significant difference in locomotion and object control abilities. Children from lower socio-economic backgrounds were generally less developed in the areas of locomotion and object control abilities, compared to children from higher income households (Bellows *et al*., 2017:997).

The socio-economic differences between the schools in the current study showed no significant difference in the pre-evaluation results for the GMS of the children. This could be attributed to the fact that poverty is closely linked to less opportunity in developing fine motor skills (De Barros *et al*., 2003:1678).

Socioeconomic differences in visual-motor integration

Research has shown a strong correlation between children's SES and VMI abilities. Poverty is often linked to poor child development in many areas with VMI being a major affected area (Carter *et al*., 2007:145). Child development is the period of physical, cognitive and social growth, beginning at birth and lasting into adulthood (Bloem *et al*., 2017:119). VMI is important for all these areas because it helps develop coordinated GMS, sets the foundation for school readiness and allows children to function at the same level as their peers (Guo *et al*., 2014:213).

Children from low socio-economic backgrounds often do not receive as many opportunities to develop FMS, such as VMI (Lotz & Loxton, 2005:64). Goodwin (2015:52) reported that children from low socio-economic schools scored significantly lower in VMI skills than children from higher socio-economic schools. Education and living environments play a large role in a child's development. Children from low socio-economic backgrounds often do not cope as well academically and do not have the same access to extra-curricular activities as children from higher income backgrounds have. This means that children growing up in low socio-economic environments often do not have as many opportunities to develop physical and cognitive skills, such as VMI (Morley *et al*., 2017:151).

However, in the current study, it is interesting to note that the VMI pre-evaluation scores found no difference in children's VMI skills between the schools from different socio-economic backgrounds.

Interesting findings

The current study's results showed that for a number of the specific locomotion and object control skills, the experimental, as well as the control group improved over time. The reason for specific skills improving could be that these skills were practised more during outdoor play. Children are constantly exploring their environments and learning new skills and therefore, not all GMS need to be taught through means of an intervention. GMS can often be practised when children enjoy playing with each other and when they subconsciously observe how others perform specific movement patterns.

CHAPTER SIX

CONCLUSIONS, RECOMMENDATIONS AND LIMITATIONS

INTRODUCTION

Chapter Six serves to propose ways to improve future areas of research that have similar aims and motivations as the current study. This chapter will restate the hypothesis and the aims, conclude the findings of the specific objectives and provide recommendations and limitations that future research may consider.

HYPOTHESIS

Research hypothesis (H_1):

The visual motor integration skills of the neuro-typical Grade R learners participating in the self-designed gross motor skills intervention will increase.

Null hypothesis (H_0):

The visual motor integration skills of the neuro-typical Grade R learners participating in the self-designed gross motor skills intervention will not increase.

This study aimed to examine the effects of a gross motor skills intervention programme on the visual motor integration skills of Grade R learners. The specific objectives of this study were: 1) to determine the level of visual-motor integration of Grade R learners.; 2) to determine the level of gross motor ability of Grade R learners; and 3) to determine whether a gross motor skills intervention had a correlation with the visual-motor integration of Grade R learners.

DEMOGRAPHIC PROFILING

Gender

The current study found no statistically significant difference between boys and girls in terms of GMS and VMI skills.

A number of studies over the years have investigated gender differences in 5- to 6-year-old children's GMS and VMI skills. Girls tend to outperform boys in VMI skills due to boys struggling to perform fine-motor tasks as neatly and accurately as girls (Dankert *et al*., 2003:542; Duiser *et al*., 2013:79). However, previous research tends to conclude that boys outperform girls in terms of GMS performance (Duiser *et al*., 2013:81).

Socio-economic status

The current study found no statistically significant difference between socio-economic backgrounds of children in terms of GMS and VMI skills.

Previous research has found a link between socio-economic status (SES) and children's VMI skills. Generally speaking, the lower the socio-economic background of a child, the poorer the VMI skill level (Lotz & Loxton, 2005:64; Carter *et al*., 2007:145). Children's motor skills also have a correlation with SES. Children from lower socio-economic backgrounds are generally less developed in the areas of locomotion and object control abilities when compared to children from higher income households (Bellows *et al*., 2017:997). Research indicates that poorer socio-economic backgrounds result in fewer opportunities for children to learn and practise motor and VMI skills.

GROSS MOTOR SKILLS INTERVENTION ON VISUAL-MOTOR SKILLS

Gross motor skills

The current study determined the GMS of 5- to 6-year-old participants before and after the intervention. No significant differences were found between participants pre-intervention; however, post-intervention rendered significant differences between the experimental and control groups.

Conclusions for gross motor skills

The current study found a statistical significant improvement in 5-to 6-year-old children's gross motor ability, locomotion and object control skills after the eight-week intervention when compared to their scores prior to the intervention period. A statistical significant difference was also reported between the experimental and control group post-intervention results. Therefore, it can be concluded that a GMS intervention is successful when aiming to improve 5-to 6-year-old children's overall gross motor abilities, locomotion and object control skills.

Former research regarding the development of children's GMS found a positive correlation between practise and mastery of GMS. Children partaking in interventions that focused on improving their overall GMS, locomotion and object control skills improved significantly in the performance of their gross motor abilities post-intervention (Branta & Goodway, 2003:41; Rudisill & Valentini, 2004:330; Logan *et al*., 2012:305).

Recommendations for gross motor skills

Regarding VMI skills for future studies of a similar nature to the current study, more sessions per week and a longer intervention period is recommended (Dankert *et al*., 2003:548; Desoete *et al*., 2012:490). Future studies should focus on improving specific aspects of GMS. For example, when looking to improve children's locomotor abilities, research should be specific with regard to which locomotor skills will be the focus (e.g. running and hopping) (Deli & Zachopoulou, 2006:11).

Visual motor integration skills

The current study determined the VMI of 5- to 6-year-old participants before and after the intervention. No significant differences were found between participants pre-intervention; however, post-intervention rendered significant differences between the experimental and control groups.

Conclusions for visual-motor integration

The current study showed a significant difference in VMI abilities of 5-to 6-year-old children when comparing the control and experimental groups and when comparing the pre- and post-test results of the experimental group. The experimental group improved significantly after the intervention compared to their previous scores. The same was true for visual perception and motor coordination skills.

Previous research incorporating VMI skills in intervention programmes for 5-to 6-year-old children have found that children's VMI levels improve when pre- and post-evaluation results are compared (Chow & Tseng, 2000:86; Dankert *et al*., 2003:548).

Therefore, the conclusion is that a GMS intervention programme can successfully improve children's VMI abilities.

Recommendations of visual-motor integration

The current study made use of an eight-week gross motor intervention programme, including one session of 30 minutes and three activities focusing on different, but related skills per week. As most intervention-focused studies report, more sessions per week and a longer intervention period will in most cases result in more positive results (Dankert *et al*., 2003:548; Desoete *et al*., 2012:490). VMI skills are linked more closely to fine-motor skills; therefore, future interventions aiming to improve children's VMI skills should incorporate more fine-motor tasks, such as drawing and writing. This should be in combination with gross motor tasks (Dankert *et al*., 2003:548).

ADDITIONAL RECOMMENDATIONS

Additional recommendations based on the findings and conclusions of this study are:

- A larger sample size can be more useful in terms of making conclusions, assumptions and generalisations of children's overall performance.
- Participants should be from a larger geographical area and from a greater variety of socio-economic backgrounds in order to draw generalisations about a population.

- Grade R teachers and parents should be more directly involved in the study to ensure encouragement and motivation for the children to perform optimally.
- Specificity of the activities for the intervention period by focusing on developing specific skills as a task as opposed to focusing generally on too many skills.

LIMITATIONS

- The sample size of the study became smaller due to a number of absentees of the children on testing days and/or during the intervention period. A parent not giving consent was another factor that limited the sample size.
- Time constraints due to school hours and lunch times, as well as school holidays and term dates.
- The unpredictable and temperamental nature of children between the ages of 5 and 6 years could have resulted in children not performing optimally on testing days or during the intervention period.
- Children’s erratic nature could also have resulted in a number of children acting as distractions to the other children during the testing and intervention period of this study.
- The effect of a quasi-experimental research design means that the treatment and class effect are confounded.

CONCLUSIONS

There seems to be a clear link between GMS and VMI. The results indicated that when one of these areas of development was enhanced, the other area was positively affected as well. In developing 5-to 6-year-old children’s locomotor and object control skills, their visual perceptual and motor coordination abilities improved, further substantiating that these skills co-develop.

GMS and VMI activate the same parts of the brain; therefore, when children learn and develop skills in either one of these areas, they can draw on those skills to enhance the other area. These skills cannot be taught in isolation. For example, the current study showed that the experimental group significantly improved their object manipulation abilities, specifically regarding dribbling, striking and catching. The current study also showed that the experimental group significantly improved in their visual perceptual skills. This shows that in order to manipulate a ball in an efficient manner, visual perceptual skills are being used and enhanced.

In conclusion, it is important to note that the current study suggests that South African children between the ages of 5 and 6 years can also greatly benefit from a GMS intervention.

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APPENDICES

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APPENDIX A

Western Cape Government
Education

Directorate: Research

Audrey.wyngaard@westerncape.gov.za

tel: +27 021 467 9272

Fax: 0865902282

Private Bag x9114, Cape Town, 8000

wced.wcape.gov.za

REFERENCE: 20170324 –9417

ENQUIRIES: Dr A T Wyngaard

Ms Nicola De Villiers
Department of Sport Science
Suidwalweg
Stellenbosch University
Stellenbosch
7600

Dear Ms Nicola De Villiers

RESEARCH PROPOSAL: EFFECTS OF A VISUAL-MOTOR INTEGRATION INTERVENTION ON THE GROSS MOTOR SKILLS OF TYPICALLY DEVELOPING GRADE R LEARNERS

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

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The Study is to be conducted from **18 April 2017 till 29 September 2017**
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
7. Should you wish to extend the period of your survey, please contact Dr A.T Wyngaard at the contact numbers above quoting the reference number?
8. A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
9. Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.
10. A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to:

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

We wish you success in your research.

Kind regards.
Signed: Dr Audrey T Wyngaard
Directorate: Research
DATE: 24 March 2017

Lower Parliament Street, Cape Town, 8001
Private Bag X9114, Cape Town, 8000
tel: +27 21 467 9272 fax: 0865902282

Employment and salary enquiries: 0861 92 33 22
Safe Schools: 0800 45 46 47
www.westerncape.gov.za

UNIVERSITEIT STELLENBOSCH UNIVERSITY

ETHICS APPROVAL

NOTICE OF APPROVAL

REC Humanities Amendment Form

11 June 2018 Project number: 328
SU-HSD-
004464 Project Title: Effects of a visual-motor integration intervention on the gross motor skills of typically developing Grade R learners.

Dear Dr. Eileen Africa Your REC H
May 2018 was reviewed and approved by the REC: Humanities. Please note the following for your approved submission: **Ethics approval period:**

GENERAL COMMENTS:

Please take note of the General Investigator Responsibilities attached to this letter. You may commence with your research after complying fully with these guidelines.

If the researcher deviates in any way from the proposal approved by the REC: Humanities, the researcher must notify the REC of these changes.

Please use your SU project number (3287) on any documents or correspondence with the REC concerning your project.

Please note that the REC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

FOR CONTINUATION OF PROJECTS AFTER REC APPROVAL PERIOD

Please note that a progress report should be submitted to the Research Ethics Committee: Humanities before the approval period has expired if a continuation of ethics approval is required. The Committee will then consider the continuation of the project for a further year (if necessary)

Included Documents:

If you have any questions or need further help, please contact the REC office at cgraham@sun.ac.za. Sincerely, Clarissa Gra
Ethics Committee: Human Research (Humanities)

National Health Research Ethics Committee (NHREC) registration number: REC-050411-032. The Research Ethics Committee: Humanities complies with the SA National Health Act No.61 2003 as it pertains to health research. In addition, this committee abides by the ethical norms and principles for research established by the Declaration of Helsinki (2013) and the Department of Health Guidelines for Ethical Research: Principles Structures and Processes (2nd Ed.) 2015. Annually a number of projects may be selected randomly for an external audit.

Protocol approval date (Humanities)	Protocol expiration date

(Humanities)
11 June 2018 10 June 2019

Document Type File Name Date Version
Research Protocol/Proposal Visual-motor integration intervention Proposal 2018 25/04/2018 2

Investigator Responsibilities Protection of Human Research Participants

Some of the general responsibilities investigators have when conducting research involving human participants are listed below:

1. Conducting the Research. You are responsible for making sure that the research is conducted according to the REC approved research protocol. You are also responsible for the actions of all your co-investigators and research staff involved with this research. You must also ensure that the research is conducted within the standards of your field of research.

2. Participant Enrollment. You may not recruit or enroll participants prior to the REC approval date or after the expiration date of REC approval. All recruitment materials for any form of media must be approved by the REC prior to their use.

3. Informed Consent. You are responsible for obtaining and documenting effective informed consent using **only** the REC-approved consent documents/process, and for ensuring that no human participants are involved in research prior to obtaining their informed consent. Please give all participants copies of the signed informed consent documents. Keep the originals in your secured research files for at least five (5) years.

4. Continuing Review. The REC must review and approve all REC-approved research proposals at intervals appropriate to the degree of risk but not less than once per year. There is **no grace period.** Prior to the date on which the REC approval of the research expires, **it is your responsibility to submit the progress report in a timely fashion to ensure a lapse in REC approval does not occur.** If REC approval of your research lapses, you must stop new participant enrollment, and contact the REC office immediately.

5. Amendments and Changes. If you wish to amend or change any aspect of your research (such as research design, interventions or procedures, participant population, informed consent document, instruments, surveys or recruiting material), you must submit the amendment to the REC for review using the current Amendment Form. You **may not initiate** any amendments or changes to your research without first obtaining written REC review and approval. The **only exception** is when it is necessary to eliminate apparent immediate hazards to participants and the REC should be immediately informed of this necessity.

6. Adverse or Unanticipated Events. Any serious adverse events, participant complaints, and all unanticipated problems that involve risks to participants or others, as well as any research related injuries, occurring at this institution or at other performance sites must be reported to Malene Fouche within **five (5) days** of discovery of the incident. You must also report any instances of serious or continuing problems, or non-compliance with the RECs requirements for protecting human research participants. The only exception to this policy is that the death of a research participant must be reported in accordance with the Stellenbosch University Research Ethics Committee Standard Operating Procedures. All reportable events should be submitted to the REC using the Serious Adverse Event Report Form.

7. Research Record Keeping. You must keep the following research related records, at a minimum, in a secure location for a minimum of five years: the REC approved research proposal and all amendments; all informed consent documents; recruiting materials; continuing review reports; adverse or unanticipated events; and all correspondence from the REC

8. Provision of Counselling or emergency support. When a dedicated counsellor or psychologist provides support to a participant without prior REC review and approval, to the extent permitted by law, such activities will not be recognised as research nor the data used in support of research. Such cases should be indicated in the progress report or final report.

9. Final reports. When you have completed (no further participant enrollment, interactions or interventions) or stopped work on your research, you must submit a Final Report to the REC.

10. On-Site Evaluations, Inspections, or Audits. If you are notified that your research will be reviewed or audited by the sponsor or any other external agency or any internal group, you must inform the REC immediately of the impending audit/evaluation.

LANGUAGE EDITING

I, Prof Karel J. van Deventer, hereby declare that I undertook the technical and language editing of the M thesis entitled, *Effects of a gross motor skills intervention on visual-motor integration of neuro-typical 5- to 6-year-old children*.

Yours faithfully

Prof Karel J. van Deventer

(Emeritus Associate Professor [Retired])

APPENDIX B

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STELLENBOSCH UNIVERSITY
CONSENT TO PARTICIPATE IN RESEARCH

Parent/Legal guardian

You are kindly requested to allow your child to participate in a research study conducted by Nicky de Villiers, a Sport Science Graduates currently doing her Masters in Kinderkinetics at Stellenbosch University. Data collected from this research study will be going towards a research paper. Your child was identified as a possible participant for this study because he/she meets the inclusion criteria of being a Grade R learner attending the selected school. This study has been approved by the ethics committee of Stellenbosch University.

1. PURPOSE OF THE STUDY

This study is designed to investigate the effect of a gross motor skills programme on visual-motor integration of neuro-typical children in Grade R.

2. PROCEDURES

If you allow your child to volunteer in this study, we would ask him/her to do the following things:

- Undergo the Beery Test of Visual Motor Integration to gain a comprehensive understanding of your children's hand-eye coordination skills. This test consists of two parts:
  - o To copy a sequence of images beginning with a single line and progressing to more complex geometric forms.
  - o To copy a sequence of images by tracing the interior of the shape, following specific directions provided in each shape.
- Your Child's ball skills and gross motor skills will be evaluated with an assessment tool for gross motor development (TGMD).
- The TGMD consists of 2 sections – locomotion and object control:
  - o Locomotion:
    - Run
    - Gallop
    - Hop
    - Leap
    - Horizontal jump
    - Slide
  - Object control:
    - Striking a stationary ball
    - Stationary dribble
    - Kick
    - Catch
    - Overhand throw
    - Underhand roll

- Testing consists of 2 weeks prior and post the 8-week intervention. The intervention entails one 30minute session a week for 8 weeks.

3. POTENTIAL RISKS AND DISCOMFORTS

Potential inconveniences during this study could be:

- Children may not be comfortable with physical activity in group settings.
- Possible injuries due to physical activity.
- Lack of fitness may cause certain aspects of the intervention to be unpleasant for the children.

4. POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY

This study aims to benefit the participants in the following possible ways:

- Increase in fitness levels.
- Increase in ball skills and sporting activities.
- Improvement in daily functioning.
- Social interaction and fun.
- Developing new skills and experiencing new activities.

This study aims to benefit science and society in the following possible ways:

- Provides new information and research regarding the benefits of improving gross motor skills with a visual motor integration intervention:

5. PAYMENT FOR PARTICIPATION

This study requires participants to volunteer their time and therefore payment is not given.

6. CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be identified with you or your child will remain confidential and will be disclosed only with your permission or as required by law. Confidentiality will be maintained by means of password protected computer programmes, only the investigator and supervisor will have this data on a memory stick or filed away as hard copies for research purposes only.

Data will be strictly confidential and only viewed by the investigator. If data is shown to or distributed to any other party, it will only be to our research supervisor, Dr E. Africa.

If any of this research is published for scientific reasons, your child's name will remain anonymous and data collected is used to determine overall results and conclusions for the study, as opposed to releasing each child's results individually.
The study is strictly only observational. None of the sessions will be audio or videotaped and if unforeseen reasons occur that require the need to audio or videotape, participants and guardians of participants will be informed and consent will be requested.

Information may only be released by the Department of Sport Science, where information will be kept confidential and safe prior to release.

7. PARTICIPATION AND WITHDRAWAL

You can choose whether your child may be in this study or not. If you volunteer your child to be in this study, you may withdraw him/her at any time without consequences of any kind. The participation is entirely voluntary. If you say no, this will not affect you negatively in any way whatsoever. You may also refuse to answer any questions you don't want to answer and your child may still remain in the study. The investigator may withdraw your child from this research if circumstances arise which warrant doing so. Participants will only be asked to withdraw from the study if they have experienced injury or illness that would cause activity to be harmful to the participant.

8. IDENTIFICATION OF INVESTIGATORS

If you have any questions or concerns about the research, please feel free to contact

Principal Investigator:
Nicky de Villiers
Cell: 072 870 4819
E-mail: ndivvy95@gmail.com

Supervisor:
Dr E. Africa
E-mail: africa@sun.ac.za

9. RIGHTS OF RESEARCH SUBJECTS

You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research subject, contact Ms Maléne Fouché [mfouche@sun.ac.za; 021 808 4622] at the Division for Research Development.

SIGNATURE OF RESEARCH SUBJECT OR LEGAL REPRESENTATIVE

The information above was described to me by Nicky De Villiers in English and I am in command of this language or it was satisfactorily translated to me.

I hereby consent that my son/daughter may participate in this study.

____
Name of Participant

____
Name of Parent / Legal Guardian

______________________________ ______________
Signature of Parent / Legal Guardian **Date**

SIGNATURE OF INVESTIGATOR

I declare that I am in agreement with the information given in this document to ______________________________________ [name of the participant] and his/her legal guardian ______________________________________ [name of the legal guardian*]*.

____ ______________

Signature of Investigator **Date**

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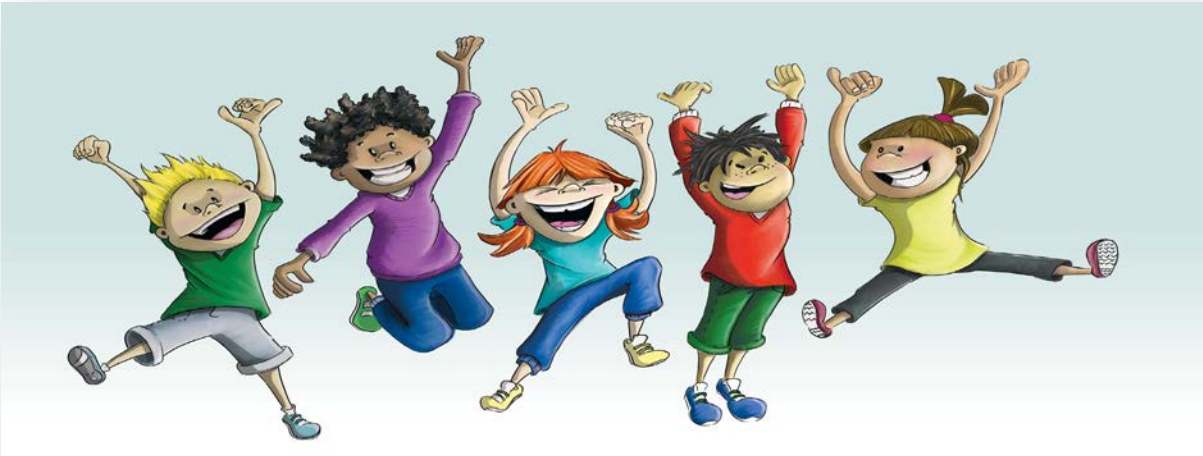


PARTICIPANT INFORMATION LEAFLET AND ASSENT FORM

Title of the research project:

Effects of a gross motor skills intervention on visual-motor integration of neurotypical 5-6 year old learners.

Researcher's name:

Nicky De Villiers

Contact number:

072 870 4819

What is Research?

Research is something we do to find new knowledge about the way things and people work.

What is this research project all about?

Helping you to be even better in the following areas:

Sport

Why have I been invited to take part in this research project?

To help you trust in your own abilities and to enjoy moving around in a fun way.

Who is doing the research project?

Nicky and other students at Stellenbosch University will be doing fun activities with you.

What will happen to me in this study?

You will learn to play fun games outside that will help you to move better.

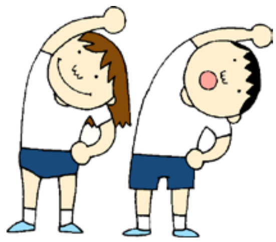
Can anything bad happen to me?

Nothing bad will happen to you.

Can anything good happen to me?

Lots of good things can happen!

Have fun with friends



Exercise

Fit and strong

Will anyone know I am in the study?

Only your parents and teachers will know that you are in the study.

Who can I talk to about the study?

You can talk to us if you have any questions.

What if I do not want to do this?

You may stop at any time but we shall miss you ☺

Do you understand the research study?

 YES  NO

Would you be willing to take part in this study?

 YES  NO

Have all your questions been answered?

 YES  NO

Do you understand that you can stop at any time?

 YES  NO

Signature of child ____________________ Date ________________

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STELLENBOSCH UNIVERSITEIT
TOESTEMMING OM DEEL TE NEEM AAN STUDIE

Ouer / Wettige voog

U toestemming word vcriendelik versoek dat u kind aan 'n navorsingstudie, wat deur Nicky de Villiers, ′n Meesters student by die Departement Sportwetenskap, Stellenbosch Universiteit, mag deelneem. Die Data versamel tydens hierdie navorsingstudie sal gebruik word in 'n navorsingsverslag. U kind is gekies as 'n moontlike deelnemer aangesien hy / sy voldoen aan die kriteria van ′n Graad R leerder in die geselekteerde skool. Die studie is deur die Stellenbosch Universiteit se etiese komitee goedgekeur.

1. DOEL VAN DIE STUDIE

Hierdie studie is ontwerp om die effek van 'n groot motoriese vaardigheidsprogram op die visueel-motoriese integrasie van 'n kind in Graad R te ondersoek.

2. PROSEDURES

Indien u toestemming verleen dat u kind vrywilliglik aan hierdie studie mag deelneem, sal ons hom / haar vra om die volgende te doen:

- Om aan die Die Beery Toets vir Visuele Motoriese Integrasie onderwerp te word om sodoende 'n omvattende begrip van u kind se hand-oog koördinasie vaardighede te bekom.. Hierdie toets bestaan uit twee dele:
- Om ′n 'n reeks beelde wat met 'n enkele reël begin en na meer komplekse meetkundige vorms vorder, te kopieer. Om 'n reeks beelde aan die binnekant van ′n vorm op te spoor en volgens spesifieke aanwysings vir elke vorm, te kopieer Na afloop hiervan, sal u kind se bal- en groot motoriese vaardighede met die *Toets vir groot motoriese ontwikkeling* (TGMD) bepaal word.
- Die TGMD bestaan uit twee afdelings - voortbeweging en objek beheer:
  - Beweging:
    - Hardloop
    - Galop
    - Hop
    - Sprong
    - Horisontale sprong
    - Gly
  - Objek beheer:
    - Slaan ~~‘n~~’n statiese bal
    - Statiese dribbel
    - Skop
    - Vang
    - Oorhand gooi
    - Onderhand rol

Die evaluering vind plaas 2 weke voor en 2 weke na die intervensie. Die intervensie behels een, 30 minuut sessie per week vir 8 weke.

3. POTENSIËLE RISKO'S EN ONGEMAK

Potensiële ongerief vir u kind tydens hierdie studie mag die volgende behels:

• Kinders mag ongemaklik voel tydens deelname aan fisieke aktiwiteite.
• Moontlike beserings as gevolg van deelname aan fisieke aktiwiteite.
•Gebrek aan fiksheid kan veroorsaak dat sekere aspekte van die intervensie onaangenaam vir u kind mag wees.

Mediese inligting word verlang van elke deelnemer om sodoende die deelname van ʼn hoë risiko kind te verhoed.
As u kind beseer sou word, sal die standaard skool protokol vir beserings gevolg word.

4. POTENSIËLE VOORDELE VIR DEELNEMERS EN/OF DIE SAMELEWING

Deelnemers sal op die volgende maniere by die studie baat vind

• 'n Toename in fiksheidsvlakke.
• 'n Toename in balvaardighede en sportaktiwiteite.
• Verbeter in die daaglikse funksionering.
• Sosiale interaksie en pret.
• Die ontwikkeling van nuwe vaardighede en deelname aan nuwe aktiwiteite.

Hierdie studie beoog om aan die gemeenskap voordele op die volgende maniere te verskaf:

- Nuwe inligting en navorsing rakende die voordele van ʼn visueel-motoriese integrasie program:

5. BETALING VIR DEELNAME

Geen betaling sal aan deelnemers gegee word nie.

6. VERTROULIKHEID

Enige inligting wat verkry word in verband met hierdie studie en wat geïdentifiseer kan word met u of u kind sal vertroulik bly. Dit sal slegs bekend gemaak word met u toestemming of soos deur die wet vereis. Vertroulikheid sal deur middel van 'n wagwoord-beskermde rekenaar gewaarborg word en daarom sal slegs die ondersoeker en die studieleier hierdie data op 'n geheuestokkie hou of liasseer as ʼn harde kopie slegs vir navorsingsdoeleindes.

Indien enige van hierdie navorsing vir wetenskaplike redes gepubliseer word, sal u kind se naam anoniem bly en data wat ingesamel word, sal gebruik word om algehele resultate en gevolgtrekkings van die studie te bepaal, dus sal individue se name nie individueel bekend gemaak word nie.

Inligting mag slegs vrygestel word deur die Departement van Sportwetenskap, waar die inligting vertroulik en veilig gehou sal word voordat dit vrygestel word.

7. DEELNAME EN ONTTREKKING

U kan kies of u kind aan die studie mag deelneem. As u vrywillig instem dat u kind aan die studie mag deelneem, mag hy/sy enige tyd tydens die studie daaraan onttrek sonder enige nagevolge. Die deelname is volkome vrywillig. Indien u nie toestemmig gee dat u kind mag deelneem aan die studie nie, sal dit geen negatiewe gevolge hê nie. Indien u verkies om enige van die vrae nie te antwoord nie sal u kind steeds aan die studie mag deelneem. Die ondersoeker mag u kind aan die navorsing onttrek indien omstandighede ontstaan wat daartoe aanleiding gee. Deelnemers sal slegs gevra word om van die studie te onttrek indien hulle 'n besering het of siek is, wat kan veroorsaak dat die studie nadelig vir hul mag wees.

8. IDENTIFISERING VAN ONDERSOEKBEAMPTES

Indien u enige vrae of kommentaar oor die navorsing het, voel asseblief vry om ons te kontak

Hoofnavorser:
Nicky de Villiers
Cell: 072 870 4819
E-mail: ndivvy95@gmail.com

Studieleier:
Dr E. Africa
E-mail: africa@sun.ac.za

9. REGTE VAN NAVORSING KINDERS

U kan u toestemming terugtrek en deelname staak sonder enige boetes. U is nie verantwoordelik vir enige eise of regte as gevolg van u deelname aan hierdie navorsingstudie nie. As u vrae het oor u regte, kontak gerus Me Maléne Fouché [mfouche@sun.ac.za; 021 808 4622] by die Afdeling Navorsingsontwikkeling.

HANDTEKENING VAN NAVORSING DEELNEMER OF REGSVERTEENWOORDIGER

Die inligting hierbo is deur Nicky De Villiers aan my in Afrikaans verduidelik en dit is bevredigend vertaal.

Ek stem hiermee in dat my seun / dogter aan hierdie studie mag deelneem. Ek beskik oor 'n afskrif van hierdie vorm.

____

Naam van deelnemer

____

Naam van ouer/ regsverteenwoordiger

______________________________________ ______________

Handtekening van ouer/ regsverteenwoordiger **Datum**

HANDTEKENING VAN ONDERSOEKER

Ek verklaar dat ek ten volle saam stem met die inligting vervat in hierdie dokument soos voorsien aan __________________________________ [naam van die deelnemer] en sy / haar wettige voog __________________________________ [naam van die ouer / wettige voog].

______________________________________ ______________

Handtekening van ondersoeker

DEELNEMER INLIGTINGSBLAD EN TOESTEMMINGSVORM

Titel van die navorsingsprojek:

Effek van 'n groot motoriese vaardigheidsintervensie op visuele motoriese integrasie van Graad R leerders.

Ondersoeker se naam:

Nicky De Villiers

Kontak nommer:

Nicky De Villiers: 072 870 4819

Wat is navorsing?

Navorsing is iets wat ons doen om nuwe kennis oor hoe dinge en mense werk, uit te vind.

Waaroor handel hierdie navorsingsprojek?

Dit help jou om beter te wees in die volgende aspekte:

Sport

Hoekom is ek uitgenooi om aan hierdie navorsing deel te neem?
Om jou te help vertrou in jou eie vermoëns.

Wie doen die navorsingsprojek?

Nicky en ander studente by Stellenbosch Universiteit doen pretvolle aktiwiteite saam met jou.

Wat sal met my gebeur?

Jy sal lekker speletjies buite speel. Die speletjies sal jou bewegings verbeter.

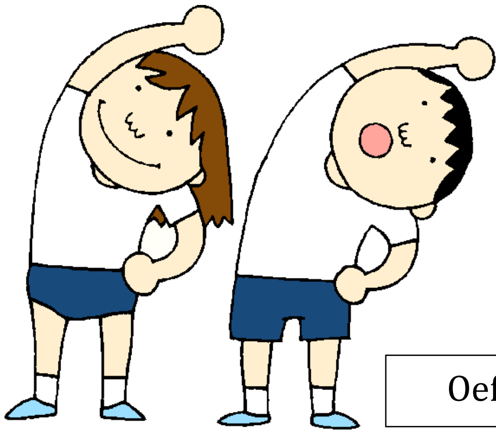
Kan enigiets sleg gebeur?

Niks slegs sal met jou gebeur nie.

Kan enigiets goed gebeur?

Baie positiewe dinge kan gebeur!

Speel met maatjies



Oefening

Fiks en sterk

Sal iemand weet dat ek aan die studie deelneem?

Net jou ouers en jou onderwysers sal weet.

Wie kan ek vrae vra oor die studie?

Jy kan vir Nicky en die ander studente vrae vra.

Wat sal gebeur as ek nie aan die aktiwiteite wil deelneem nie?

Jy mag die studie verlaat, maar ons sal jou mis ☺

Verstaan jy die navorsingstudie?

JA

NEE

Wil jy aan die studie deelneem?

JA

NEE

Het jy enige vrae?

JA

NE

Verstaan jy dat jy die studie enigetyd kan verlaat?

JA

NEE

Handtekening van kind ____________________ Datum _______________

APPENDIX C

TABLE 4. 1: MEANS/ STANDARD DEVIATIONS OF OUTCOME MEASUREMENTS OF GMS

	Cont/Pre	Cont/Post	Exp/Pre	Exp/Post	p-value	Cont change	Exp. change
GMQ	91.41(10)[b]	90.47(8.9)[b]	91.36(11)[b]	99.91(11)[a]	*0	-0.89	8.59
Locomotion	8.7(2.43)[b]	8.6(2.05)[b]	8.35(1.97)[b]	9.52(1.83)[a]	*0	-0.1	1.17
Hop	5(2.17)[b]	4.98(2.16)[b]	5.14(1.18)[b]	5.19(1.41)[b]	0.84	-0.02	0.05
Jump	5(0.97)[b]	4.88(0.84)[b]	4.78(1.1)[b]	5.47(1.14)[a]	*0.01	-0.12	0.69
Gallop	3.07(1.93)[ab]	3.02(1.86)[ab]	2.92(2.1)[b]	3.71(2.04)[a]	0.094	-0.05	0.79
Run	6.41(1.61)[b]	6.93(1.23)[b]	6.65(1.49)[b]	7.02(1.27)[b]	0.648	0.52	0.37
Leap	3.32(0.82)[b]	3.37(0.77)[b]	3.35(0.98)[b]	3.8(1.09)[a]	0.107	0.05	0.45
Slide	4.24(2.2)[a]	3.95(2.56)[a]	3.91(2.55)[a]	4.54(2.31)[a]	0.12	-0.29	0.63
Object Control	8.4(1.72)[b]	8.43(1.43)[b]	8.82(2.1)[b]	9.84(1.93)[a]	*<0.01	0.02	1.05
Dribble	4.05(0.92)[b]	3.95(0.92)[b]	4.03(1)[b]	4.69(1.11)[a]	*0	-0.1	0.66
Overarm throw	3.22(1.41)[b]	3.83(1.46)[b]	3.08(1.5)[a]	4.03(1.45)[a]	0.39	0.61	0.95
Kick	4.27(0.9)[b]	4.46(0.74)[b]	4.29(1.1)[b]	4.38(1.08)[b]	0.62	0.19	0.09
Strike	5.24(2.36)[ab]	5.61(2.48)[ab]	5.66(2.46)[b]	6.65(2.43)[a]	0.195	0.37	0.99
Underhand Roll	3.63(1.74)[b]	3.49(1.61)[b]	4.08(2.08)[b]	3.68(1.89)[b]	0.58	-0.14	-0.4
Catch	4.39(1.5)[b]	4.59(1.43)[b]	4.65(1.34)[b]	5.32(1.09)[a]	0.089	0.2	0.67

***Note*: Cont/Pre = Control group Pre-test; Cont/Post = Control Post-test; Exp/Pre = Experimental group Pre-test; Exp/Post = Experimental group Post-test; * =** $p \leq 0.05$

Subscript letters indicate significant mean differences at 5% ($p \leq 0.05$). If at least one letter overlaps (eg. “a” vs. “ab”) then it indicates no significant difference. If there are no overlapping letters (eg. “a” vs. “bc”) then the difference is significant.

TABLE 4.2: P-VALUES OF THE OUTCOME MEASUREMENTS OVER TIME FOR THE EXPERIMENTAL AND CONTROL GROUPS

Outcome Measurement	p-values			
	Exp. Pre/ Cont Pre	Exp. Post/ Cont Post	Exp. Pre/ Exp. Post	Cont Pre/ Cont Post
GMQ	0.54	0	0	0.39
Locomotion	0.21	0.09	0	0.6
Hop	0.94	0.78	0.82	0.94
Jump	0.32	0.01	0	0.59
Gallop	0.83	0.1	0.01	0.9
Run	0.55	0.88	0.06	0.04
Leap	0.98	0.05	0	0.8
Slide	0.46	0.32	0.09	0.53
Object Control	0.64	0	0	0.93
Dribble	0.88	0	0	0.61
Overarm Throw	0.65	0.5	0	0.05
Kick	0.97	0.62	0.61	0.3
Strike	0.78	0.19	0	0.33
Underhand Roll	0.34	0.72	0.16	0.68
Catch	0.65	0.05	0	0.38

TABLE 4.3: P-VALUES OF THE OUTCOME MEASUREMENTS OVER TIME FOR THE EXPERIMENTAL AND CONTROL GROUPS

***Note*: Cont/Pre = Control group Pre-test; Cont/Post = Control Post-test; Exp/Pre = Experimental group Pre-test; Exp/Post = Experimental grouep Post-test; * =** $p \leq 0.05$

Outcome Measurement	Cont/Pre	Cont/Post	Exp./Pre	Exp./Post	p-value	Cont. change	Exp. change
VMI	93.4(14.41)[ab]	95.27(16.09)[ab]	95.56(11.59)[b]	101.79(13.06)[a]	*<0.01	0.75	5.53
Visual perception	87.1(16.55)[b]	89.66(16.23)[b]	91.27(16.44)[b]	98.76(14.1)[a]	*0.01	1.93	7.51
Motor Coordination	94.9(12.61)[b]	95.68(13.74)[b]	97.78(10.32)[b]	106.13(11.64)[a]	*0	1.23	8.49

TABLE 4.4: P-VALUES OF THE OUTCOME MEASUREMENTS OVER TIME FOR THE EXPERIMENTAL AND CONTROL GROUPS

	p-values			
Outcome Measurement	**Exp. Pre/ Cont Pre**	**Exp. Post/ ContPost**	**Exp. Pre/ Exp. Post**	**Cont Pre/ Cont Post**
VMI	0.84	0.61	0	0.54
Visual Perception	0.98	0.03	0	0.21
Motor Coordination	0.85	0	0	0.69

APPENDIX D

EQUIPMENT	DESCRIPTION
Tennis ball	Diameter: ±6.5cm
Basket ball	Diameter: ±24cm
Soccer ball	Diameter: ±22cm
Colour balls	Diameter: ±5.5cm in at least 3 different colours
Recycled balls	Diameter: ±3cm Rolled-up A4 newspaper sheet, sealed into a ball using duct tape
Mini hurdle	Width: 45cm Height: 7.5cm
Hurdle	Width: 45cm Height: 15cm
Mini cone	Height: 10.16cm
Medium cone	Height: 50cm
Traffic cone	Height: 100cm Width: 50cm
Hopscotch square	±60cmx60cm
Hula hoop	Diameter: ±90cm
Hula hoop stand	Wooden
Ring	Diameter: ±15cm
Rope	Length: 200cm
Frisbee	Diameter: 25cm
Beanbag	±10cmx10cm
Material bands	Length: ±60cm in at least 3 different colours
Rocks	Colourful sensory balance rocks in a variety of different heights
Plastic shapes	Different colour plastic shapes: triangle, circle, square Diameter: ±40cm
Tactile hands	Colourful sensory tactile hands
Tactile feet	Colourful tactile sensory feet
Cone	Colourful cones with grooves to allow for rods/shapes to fit into
Black bag	Normal refuse bags
Crayons	10 different colours
Paper cup and string	250ml cup String length: 60cm One end of string stuck to the bottom of the cup using celotape
Peg	Any washing line pegs
Toilet roll	Standard toilet rolls
Toilet roll cut-off	¼ toilet roll (standard toilet roll cut width wise int 4 parts)
Top half of milk bottle	2l milk bottle cut in half width way
Bottom half of milk bottle	2l milk bottle cut in half width way
Baby powder	250ml container of baby powder
Black paper	A4 sheet of black paper
Infinity signs	Handdrawn infinity signs on A3 paper
Paper templates of shapes in different sequences	Template size: A4 paper Sequences: alternating between circles, squares and triangles
Newspaper cut-outs of shapes	Big shapes: A4 paper size Small shapes: A6 paper size
Elastic bands	Rubber elastic bands
Duct tape	
Prestik	

APPENDIX E

WEEK 1

Date: 14 August 2017
Time: 30 minutes

Equipment:
- 5 ropes
- 6 tennis balls
- 9 rings
- 8 cones
- 8 colour balls
- 6 frisbees
- 6 toilet rolls

Theme: Fruits

Warm up
- Presenter has 3 different printed fruits, A4 size, stuck on sticks. These act as 3 different instructions.
- Presenter explains to the children what movement each fruit represents and that children must perform the movement that matches with the fruit that they see.
- Children scatter around the room/field and wait for the presenter to hold up a fruit.
  - Apple: run
  - Orange: jump
  - Strawberry: stop

Station 1
Picking apples

Main focuses	Underarm roll, hand-eye coordination
Extra focuses	Balance, laterality, bilateral coordination, foot-eye coordination, spatial awareness

- Ropes are laid out on the ground in the shape of a tree.
  - 2 ropes lie vertically and perpendicularly to each other (the trunk of the tree).
  - 2 or 3 other ropes are positioned at the top of each of the original ropes. These spread out in different directions (the branches of the tree).
  - At the end of each "of these ropes (the branches), there is a tennis ball (an "apple").
- Children line up in two lines behind the beginning of each side of the trunks of the tree.
- Children walk along the rope and pick up one ball/apple, then run back to the start where they take it in turns to roll the ball to a line of cones, attempting to hit one of the cones.
- Presenter catches tennis ball and puts it back on the rope "tree" to allow the children to begin again.
- PROGRESSION: now children pick the ball up, put it on a toilet roll, and must balance it back to the beginning.
- PROGRESSION: Children walk sideways on the rope.

Station 2
Stomping grapes to make juice

Main focuses	Horizontal jump, hop
Extra focuses	Directionality, foot-eye coordination, proprioception, balance, spatial awareness, bilateral coordination, laterality, colour recognition

- A grid of arrows pointing in different directions are laid out on the ground.
  - Each arrow is printed black and bold on an A4 sized piece of paper.
  - The grid is set out as 5x5 with arrows pointing in different directions (presenter may choose how much he/she wants to keep changing the direction).
  - Arrows are stuck onto the ground, 15cm space between each arrow.
- Children go one by one, when instructed to, and jump with two feet on each arrow. Each jump must be in the direction of the arrow they have just landed on.
- 2m beyond the grid, a line of differently coloured rings is laid out in a zigzag pattern.
- Children must hop from ring to ring until the end of the line and try to maintain their balance while doing so.
- PROGRESSION: The rings are now scattered around the grid.
- Children continue to jump around from arrow to arrow, but when the presenter says "stop stomping", the children have to look at the colour dot on their arrow and run to a ring that is the same colour.
- Stand on one leg on the ring until it is time to get back to stomping (presenter lets children try get/maintain balance for 10 seconds).

Station 3

Remembering what to put in the fruit salad

Main focuses	Shape recognition, hand-eye coordination
Extra focuses	Memory, teamwork, laterality, bilateral coordination, motor planning, spatial awareness

- Presenter stands 2m in front of children. Presenter holds up a picture/template on an A4 sized piece of paper of different colour shapes in a pattern. Presenter holds the template up for about 10 seconds.
- Children are split into 2 groups for this activity.
- As a group, the children must find the right equipment, from a basket of different sorts of equipment, to replicate the picture.
- Only one piece of equipment can be fetched at a time and brought back to the starting point before the next piece can be fetched.
- The basket is 10m from the starting point. The starting point is marked out by 2 cones (1 cone for each team to stand behind).
- The group must retrieve every piece as a group by forming a train and holding onto each other's shoulders in a line.
- PROGRESSION: Children must be sure to all step with their feet in sync (right foot then left foot).

Cool down

- Children all form a circle and watch the presenter who is standing in the middle.
- Presenter performs big, obvious movements that the children must copy.
- Presenter marches on the spot and then pretends to climb a tree and pick fruit, then bends down to put the hypothetical fruits on the ground.

End off by all taking hands and making a circle.

WEEK 2

Date: 21 August 2017
Time: 30 minutes

Equipment:
- 2 hula-hoops
- 2 mini hurdles
- 2 big hurdles
- 4 beanbags
- 4 tennis balls
- 8 ropes
- 3 mini cones
- 1 traffic cone
- 6 tactile feet
- 2 hula-hoop stands
- 12 paper squares
- newspaper shapes
- paper buttons
- newspaper cut out top
- prestik and string

Theme: Sewing

Warm up
- Presenter stands in the middle of the children and explains that the children must run in the direction that he/she points in. (Point with 2 arms and turn body in that direction as well to make it visually obvious to the children where they must run).
  - When the presenter shouts “trousers”, “shirt”, “shoes”, “hat” – children must stop where they are and pretend to put on whatever item has been called.

Station 1
Thread the needle

Main focuses	Hop, hand-eye coordination
Extra focuses	Spatial awareness, body awareness, proprioception, motor planning, bilateral coordination, foot-eye coordination, laterality

- Children all stand behind a hula-hoop on a stand. The first child climbs through, almost as if threading the head of a needle.
- 3 right footed tactile feet are laid out on the ground and child now hops on these towards a traffic cone.
- Run around the traffic cone and hop on the 3 left footed tactile feet until at another hula hoop on a stand.
- Climb through this hoop the same way as the first, careful not to touch the actual hoop.
- PROGRESSION: Give child a piece of string to take through the hoop, wrap around the traffic cone and bring it back to thread through the last hoop as well.

Station 2

Sewing

Main focuses	Leap, shape recognition, hand-eye coordination
Extra focuses	Spatial awareness, foot-eye coordination, motor planning, proprioception, throwing, aiming, laterality, bilateral coordination

- Hurdles are laid out in a line, 2m apart from each other: small hurdle, big hurdle, small hurdle, big hurdle.
- Children "sew" by going over, under, over, under the hurdles.
- On return, 2 beanbags are laid down 4m away and next to the hurdles. Beanbags are 2m apart from each other. Children run towards the first beanbag and leap from one to the other.
- A shape (square) is stuck on the wall in front of the beanbags and children must pick up a tennis ball and throw it at the shape.
    - Tennis balls are next to a mini cone that stands 4m away from the wall.
    - Children must stand behind the cone when throwing at the shape (square).
- PROGRESSION: Put 2 more shapes (triangle and circle) on the wall. A mini shape of each shape (square, triangle and circle) on the wall is placed under a mini cone.
- Child stands behind the cones and chooses one to look under. Whatever mini shape he/she sees must be the shape on the wall that he/she aims at.

Station 3

Choosing buttons

Main focuses	Hand-eye coordination, shape recognition
Extra focuses	Teamwork, spatial awareness, laterality, bilateral coordination, proprioception, motor planning, dynamic balance, foot-eye coordination, motor planning

- Presenter lays paper squares on the ground in the shape of a triangle and a square. (Make the paper squares a rope length apart so that the shapes are life size).
- Children break into two smaller groups. The one group starts at the triangle while the other starts at the square.
- Children work in their mini group and take ropes to lay down on the mini paper squares until they have joined up all the squares and formed the required shape (i.e. the "button").
- Once the children have said what shape they made, they walk around the shape on the rope, careful not to touch the ground.
- Let the groups swop and make each other's previous shapes.
- Presenter can even make a circle with the paper squares afterwards and let everyone do it together.
- PROGRESSION: Everyone moves to the wall where the newspaper cut out top is stuck. A template of 3 shapes (triangle, square and circle – the buttons that we just made in groups) is next to the top on the wall. Presenter picks up a paper triangle and asks the children where on the top it must be stuck (children must look at the template on the wall and see if it is the top button/middle button/ bottom button).
- Do the same for all the buttons – let children come forward and stick it on the top.

Cool down

Children look at the presenter "putting on a top" and must all say what he/she is doing and then do the same. Put on trousers and end off with sitting down and all putting on shoes.

WEEK 3

Date: 28 August 2017
Time: 30 minutes

Equipment:
- hulahoop x 4
- string and pegs
- 10 rings (5 red and 5 blue)
- 2 shapes (1 red and 1 blue)
- 2 cones (1 red and 1 blue)
- 5 ropes
- 2 pieces of paper with templates.
- beanbag

Theme: Seasons

Warm up
- Cones are spread out on the ground (1m from each other) forming a big circle.
- Children spread their arms out like airplanes and fly between the cones (zigzagging).
- Emphasise that when they pass a cone they must bend into it (bend low and lean towards it).

Station 1
Autumn
Taking leaves off the tree

Main focuses	Hand-eye coordination
Extra focuses	Laterality, bilateral coordination, foot-eye coordination, body awareness, spatial awareness, proprioception

- Children all stand around a hulahoop with the presenter.
- When the presenter puts a body part in, everyone must copy as quickly as they can.
- Presenter looks around to see that everyone has put the right body part in (be strict with left and right). Correct those who are wrong.
- PROGRESSION: Stand with back facing the hula-hoop and do the same thing.
- Now all children lie on their backs in a circle with feet touching and look up at the hula-hoop as the presenter instructs them to put a foot (left or right) on the rim of the hoop.
- PROGRESSION 2: Then children turn and lie in a circle with heads touching and reach up to touch the hoop with pegs dangling off it. Children reach up, each take one peg off, and must return it with a different hand.

Station 2
Winter
Storing food

Main focuses	Throw, hop, hand-eye coordination
Extra focuses	Dynamic balance, colour recognition, proprioception, bilateral coordination, laterality, body awareness, spatial awareness, tactile stimulation

- Rings are lying next to each other on the floor (1m apart from each other). 5 ropes are spread out parallel to each other and perpendicularly in front of each ring on the floor. 2 cones with a shape (square and circle) on each one are positioned at the end of the ropes.
- Each child stands behind a ring.
- The presenter chooses to say “Red” or “Blue” and whoever is standing behind the colour that has been instructed must pick up their ring, put it on their head and walk on the rope leading to the cones with shapes.
- At the end of the rope, take the ring in hand and throw it through the shape of the same colour of the ring. (Children must take their ring back to the start)
- Shuffle the children around in their line for the next time so that they are not all at the same colour as the last time.
- Next time children must walk backwards on the rope.
- PROGRESSION: Instead of balancing the ring on their heads, children must put it on one of their ankles and hop to the other side (make sure that they hop with the leg with the ring on it at the back of their body).

Station 3
Spring
Making flowers

Main focuses	Gallop, VMI
Extra focuses	Motor planning, laterality, bilateral coordination, spatial awareness, proprioception, foot-eye coordination, dynamic balance

- Children stand in a line behind a cone. 5 beacons are spaced apart in a line in front of the cone (1m apart from each other).
- Children must zig zag through the beacons by doing a lazy gallop – the leading foot goes first each time and arms are bent and swung back and forth as in a normal gallop. The difference is that the non-dominant foot is being dragged behind the body (it maintains ground contact the whole time).
- Children run back and sit down once they have done this.
- PROGRESSION: After the child has now galloped properly (or attempted to) along the line of beacons, he/she is shown a picture and must now replicate it with hula-hoops. The picture is of 3 circles overlapping or of 3 circles spaced apart from each other.
- When the child does it right, he/she runs back and the next child goes.

Cool down

- Everyone forms a circle.
- Children copy presenter who “rises and sets like the sun”.
- Start looking down at left foot and stretch up above head and gradually down to the other foot. Eyes looking at hands the whole way.

WEEK 4

Date: 4 September 2017
Time: 30 minutes

Equipment:

- milk cartons
- beanbags
- soccer ball
- colour bands
- 4 cones
- 2 basket balls

Theme: Builders

Warm up:
Ask children if they know what kind of different buildings they know of and how big they are.
Everyone forms a circle and walks around doing different actions per building.

- Skyscraper (walk on tiptoes and reach up high into the air)
- Mansion (big, wide house: spread arms out and walk with open legs)
- Little house (everyone crouches down and walks on their haunches)

Station One:
Passing bricks down the line

Main focuses	Hand-eye coordination
Extra focuses	Proprioception, laterality, midline crossing, bilateral coordination, spatial awareness, vestibular stimulation, directionality

- Children stand in a circle and are each given half of a milk bottle (the side with the handle).
- A beanbag is passed around in the circle by using the milk bottles.
- Now children take a step back, change direction and throw it to each other in the circle.
- Now children turn their backs to the centre of the circle and ay not move their feet as they turn to catch and throw the beanbag.
- PROGRESSION: Children make a line, still holding their milk bottles and with their legs apart. The child in the front starts with the beanbag and passes it through their legs to the child behind.
- Once they have passed the beanbag, the child runs to the back of the line and waits to receive it again.

Station Two:
Careful not to let anything fall on the wet cement

Main focuses	Kicking
Extra focuses	Core strength, dynamic balance, static balance, teamwork, proprioception, body awareness, spatial awareness, foot-eye coordination, laterality, bilateral coordination, directionality

- Children sit in a circle and pass a soccer ball to each other by only using their feet. They may stabilise themselves with their hands, but their feet may not touch the ground (the wet cement) the whole time the ball is passed around the circle.
- Do it again with everyone lying on their backs and having their feet in the air.
- PROGRESSION: Now children stand up in the circle and each child is given a colour band to wear (blue or orange).
- A blue band must kick to an orange band. An orange band must kick to a blue band. Children must keep the ball moving in all directions in their circle keeping this pattern in mind.

Station Three:
Smooth out the ground by rolling over it

Main focuses	Dribble, hand-eye coordination
Extra focuses	Tactile stimulation, proprioception, motor planning, laterality, directionality, spatial awareness, bilateral coordination, dynamic balance, body awareness

- Children split into 2 “teams”. Each team lines up behind a cone. Each of these cones has another cone that is 3m in front of it. Each team is given a basketball and the first person in each group bends down and pushes the ball to the cone, around it and back again to the next child. Children are told to use the PALM of their hand of choice and NOT fingers.
- Next time children must push the ball only using their fingertips.
- PROGRESSION: Child in front runs to the cone, bounces the ball 3 times with one hand and then runs back again for the next child to go.

Cool down:
Stand in a circle and children copy presenters: roll head down to neck, then slowly keep curling over downwards until in a ball on the ground.
Now slowly unfold body by straightening out into a standing position – the head being the last part to straighten up.

WEEK 5

Date: 17 September 2017
Time: 30 minutes

Equipment:
- 6 ropes
- celotaped paper balls
- 5 cones
- ball
- toilet roll cut outs
- paper cups

Theme: Fire

Warm up:
- Ropes are laid in a circle on the ground.
- Everyone stands behind the rope, forming a circle.
- Presenter gives instructions of jumping over the rope:
  1. Jump with 2 feet over the rope. Jump back again.
  2. Turn sideways and do the same thing. (Presenter can choose how many times, e.g. make the children do this 4 times)
  3. Jump 2 jumps into the circle but only on one leg.
  4. Run across the circle and take a new place on the other side.
  5. Run around the circle and change direction a few times.
  6. Bear crawl with a hand on either side of the rope and switch over to a crab walk.

Station One:
Putting coal in the fire

Main focuses	Throwing, catching, rolling
Extra focuses	Hand-eye coordination, motor planning, spatial awareness, proprioception, laterality, bilateral coordination

- Ropes are laid out in a circle (3m diameter) and cones are laid in the middle.
- Children must throw a ball in a circle to each other (presenter guides the process to ensure each child gets a chance to receive and throw the ball).
- If a child drops the ball, everyone must run to the middle and touch a cone (*check if the fire is still hot).*
- PROGRESSION: Children are each given 2 duct tape paper balls and one by one attempt to roll their ball to one of the cones in the middle of the circle. (*Putting coal in the fire).*

Station Two:
Collecting leaves for the fire

Main focuses	Hand-eye coordination
Extra focuses	Left-right discrimination, motor planning, laterality, bilateral coordination, spatial awareness, body awareness

- Children line up next to each other. Toilet roll cuttings are scattered 6m in front of the children.
- Draw a dot or put a sticker on the right hand of the child and tell them that is their right hand.
- Presenter instructs each child to pick up a toilet roll cutting only using their right hand and bring it back to the start.
- Then instruct children to put it back with their left hand and return to the beginning.
- PROGRESSION: Give each child a plastic cup tied to a string. They must line up again and wait until instructed to fetch a toilet roll cutting.
- Presenter instructs them to hold the string in their left hand and thread a toilet roll cutting on with their right hand. The children return to the starting line.
- Now children fetch another cutting by holding the string in their right hand and threading with their left hand.

Station Three:

Getting sandbags to put out the fire

Main focuses	Hand-eye coordination
Extra focuses	Directionality, teamwork, vestibular stimulation, dynamic balance, spatial awareness, body awareness, bilateral coordination, laterality, proprioception

- Children get into partners and must stand back to back while linking arms.
- Partners take it in turns to bend over and lift the other child onto their back.
- Now children hold hands with their partners and spin each other in a circle. When the presenter shouts, “change direction”, children spin the other way.
- PROGRESSION: Children line up next to each other in partners.
- Partners stand back to back, bend over and take hands through their legs. They must then walk 3m like this to where there are beanbags (*sandbags).*
- Each partnership takes one beanbag and holds it between each other in the same position as they return.

Cool down:

Stand in a circle again and presenter instructs children to lie on their tummies, then arch up (like a dog yoga pose) and look at the ground. Now bring hips to the ground and look up with head.

Do this a few times.

WEEK 6

Date: 2 October 2017
Time: 30 minutes

Equipment:
- 4 tennis balls
- 2 rocks
- 8 hopscotch squares
- 6 ropes
- 2 basket balls
- 4 black bags
- baby powder
- 2 big pieces of paper with an infinity sign dotted on it
- black paper
- crayons

Theme: Painting

Warm up:
- Children run around until an instruction is shouted:
  - Paint the wall (run to a wall and pretend to paint)
  - Paint the ground
  - Paint the sky
- Actions must be emphasised and the children are encouraged to bend down, reach up or find a wall as quickly as possible.

Station One:
Painting patterns

Main focuses	VMI
Extra focuses	Hand-eye coordination, foot-eye coordination, dynamic balance, static balance, bilateral coordination, laterality, spatial awareness, body awareness, motor planning, midline crossing, proprioception

- 2 lines of hopscotch squares are lying next to each other (3m between each line) on the ground (4 hopscotch squares in each line, evenly spaced apart by 30cm). A rock lies at the end of each line.
- Children split up into 2 groups, each group standing behind a line of hopscotch squares.
- First child crouches down like a frog behind the first square and puts his/her 2 hands into the square. Then he/she hops the legs forward like a frog so that all fours are in the block. Now place hands in the next block and let feet follow in the same way all the way till the end.
- Stand on one leg on the rock for 3 seconds before running back.
- PROGRESSION: An infinity sign (A3 size) is stuck on the wall.
- Children now stand to the side of the hopscotch squares and get down into a push up position. Climb to the end of the squares by placing one hand in a square and letting the other follow into the same square before moving to the next.
- At the end, stand on one leg on the rock and pick up a crayon. Draw in between the lines of the infinity sign, careful not to draw outside the boundary lines.
- The next child takes a different colour crayon to the child just before.

Station Two:

Make sure everything is painted

Main focuses	VMI
Extra focuses	Hand-eye coordination, directionality, vestibular stimulation, proprioception, bilateral coordination, spatial awareness, teamwork

- Children stand in a circle. After they have made their circle, they turn to the side so that everyone is facing someone’s back.
- Now children pass a tennis ball one by one in the pattern of under and over (under and between the legs, over and above the head) around the whole circle. Add in another tennis ball or two and continue going until children can do it quickly.
- PROGRESSION: Black paper (6 A4 pieces of paper) is stuck in a path on the ground, 1m apart from each other.
- A tub of baby powder is standing at the start of the path.
- Children get into partners; the first partners roll a tennis ball in powder and stand on either side of the path, bouncing the ball to each other on each black piece of paper.
- Then the next pair goes until everyone has had a chance. Encourage children to try powder the whole piece of paper with powder by the end.

Station Three:

Roll the paint away

Main focuses	Hand-eye coordination
Extra focuses	Proprioception, laterality, bilateral coordination, teamwork, spatial awareness, laterality, motor planning

- Children make two lines facing each other. Whomever the child is facing is their partner.
- Each pair is given a black bag to hold between the two of them.
- The presenter stands at one end of the line and puts a basketball onto the first black bag.
- Children tip it onto the next black bag etc. until the ball reaches the end of the line.
- PROGRESSION: Children stand further apart (start with 0,5m between each pair) and try to throw the ball to each other’s’ black bag. Partners catching can move their arms and body in order to allow the ball to land in the bag and not drop to the floor.
- Add in another ball at the beginning to keep them more involved.

Cool down:

- Paint different patterns in the sky
- Paint a picture in the air and children guess what you painted:
    - Triangle
    - Circle
    - Square
    - Cross

WEEK 7

Date: 15 October 2017
Time: 30 minutes

Equipment:
- 4 tennis balls
- 2 basket balls
- 7 ropes
- duct tape
- 8 hula-hoops
- 15 beanbags
- 4 cones

Theme: Jungle

Warm up:
- Children run from one side of the field/room to the other while presenters roll hula-hoops across the ground trying to hit the children.

Station One:
Cross the river

Main focuses	Leaping
Extra focuses	Static balance, dynamic balance, foot-eye coordination, spatial awareness, body awareness, motor planning, directionality, laterality, bilateral coordination, proprioception

- Children line up behind each other.
- Two ropes are lying horizontal and parallel to each other on the ground, about 2m space between them.
- Beanbags are scattered between the ropes, any distance apart.
- Children are told to leap, one by one, from beanbag to beanbag without touching the ground.
- At the end of the river, child swims back like a fish with their hands in front of their bodies. The next child may now begin.
- PROGRESSION: Make the distance between the ropes and beanbags bigger and bigger.
- Children must leap and balance on a beanbag for 3 seconds before leaping to the next one.
- At the end of the river, child hops back like a frog.
-

Station Two:
Knock a tree over

Main focuses	Rolling, hand-eye coordination, foot-eye coordination
Extra focuses	Spatial awareness, proprioception, motor planning, laterality, bilateral coordination, body awareness

- Duct tape is stuck in parallel lines on the ground, making 4 lanes. Each lane is 3m long and 1,5m wide.
- Children stand behind a lane that the presenter has allocated them to. The front child holds a tennis ball.
- The first children must crabwalk, kick the tennis ball in their lane to the end, and back again. It may not cross over to another lane. Then the next child may go.

- Now the children must bounce and catch the ball, one by one, on one of the lines – the ball must hit the duct tape on each bounce.
- PROGRESSION: A cone is now placed at the end of each lane.
- Almost like bowling, children each have a chance to roll their ball in their lane to hit their cone/tree over.

Station Three:

Get the bugs off the flower

Main focuses	Throwing, catching
Extra focuses	Hand-eye coordination, motor planning, spatial awareness, proprioception, body awareness, bilateral coordination

- Children get into 2 lines.
- The first child in each line is given a basketball and stands at a cone, 2m from the wall. They must throw the ball against the wall and catch it with 2 hands again. Each child goes twice before the next child goes.
- PROGRESSION: Hula-hoops are stuck on the wall to make a flower shape.
- Children are told to "kill a bug on the pink petal" (pink hula-hoop) or the green petal etc.
- Whichever colour is instructed, children must throw the basketball at that colour.
- They are encouraged to catch the ball again even if it bounces once.

Cool down:

- Children sit in a circle with their feet touching. They are making a "flower".
- When the presenter says the flowers are opening up, everyone stretches out their arms and lies down on their backs.
- When the flowers close up, children sit up and roll down as far as they can.

WEEK 8

Date: 15 October 2017
Time: 30 minutes

Equipment:

- pictures of: triangle, circle, square, diamond
- page of these shapes drawn in different sequences
- 4 beanbags
- elastic bands
- 8 cones
- 5 ropes
- 10 rings

Theme: Spies

Warm up:

- Presenters stand with backs turned in the front of the children.
- Children edge forward to the presenters. When presenters hear the children, turn around and chase them.

Station One:

Secret code

Main focuses	Hopping
Extra focuses	Bilateral coordination, laterality, foot-eye coordination, memory, motor planning, dynamic balance, static balance, shape recognition, directionality, spatial awareness, body awareness

- Children line up next to each other each facing a wall.
- When the presenter says so, children do 10 alternating foot taps on the wall.
- Now everyone turns their back and does the same thing, kicking the wall with their heels.
- PROGRESSION: Shapes (circles, triangles, squares) are stuck at child's kicking level on the wall. A beanbag is placed just in front of each shape on the floor.
- Children are showed a pattern that is made up of the same 3 shapes that are stuck on the wall (a template the presenter holds up of shapes in a row).
- Children must now one by one kick the pattern that they have just seen on the wall (tell them they are pressing buttons for the secret code).
- To kick the shapes, children hop from beanbag to beanbag and must kick the shape backwards – make sure the shapes are kicked in the same order as the template.

Station Two:

Collecting treasure without being seen

Main focuses	Hand-eye coordination, jumping
Extra focuses	Foot-eye coordination, proprioception, dynamic balance, spatial awareness, bilateral coordination, laterality, body awareness, vestibular stimulation

- Ropes are spread out on the ground, some over lapping each other.
- 2 cones are positioned on either side of the rope formation.
- Children split into 2 groups and each stand at a cone on one side of the ropes.

- Elastic bands are stretched over the cones on either side. 15 elastic bands on each cone.
- One by one, children from each team must walk across the ropes (stick to one rope) and fetch an elastic band from the cone by taking it off using fingers only. Walk back on a different rope and put the elastic band on team's cone before the next child goes.
- PROGRESSION: Two ropes are now laid out in straight lines.
- Children now jump, one by one, with 2 feet side to side on the rope they are directly behind.
- Children must fetch an elastic band, one at a time, using fingers only and bring it back to the starting cone.
- See which team can collect the most elastic bands.

Station Three:
Capturing bad guys

Main focuses	Throwing, hand-eye coordination
Extra focuses	Laterality, bilateral coordination, spatial awareness, proprioception, static balance

- 4 cones are on the ground, different distances from the children (1m, 2m, 3m, 4m).
- Children line up behind a rope and they may not cross it.
- The first cone is worth 10 points, the next is 20 points etc.
- Children break up into 2 teams and must try throw their ring onto a cone.
- Add up the points each child gets for their team and see who wins.
- PROGRESSION: Children must try throwing the rings while standing on one leg.
- If children are unsuccessful in getting the ring onto the cone, place the cones within arm reaching distance.

Cool down:

- Everyone makes a circle.
- Presenter gets down on all fours, looks back between legs and turns head up again to look at everyone else. Children must copy this movement.