THE EFFECT OF A PERCEPTUAL-MOTOR INTERVENTION ON THE MOTOR PROFICIENCY, LETTER RECOGNITION AND -FORMATION OF SELECTED GRADE 1 CHILDREN.

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Thesis presented in fulfilment of the requirements for the degree of Master of Sport Science at the Department of Sport Science, Faculty of Health Science, Stellenbosch University.

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DECLARATION

By submitting this thesis electronically, I declare that the entirety of the work contained therein is my own original work, that I have read and understand the Stellenbosch University Policy on Plagiarism and the definitions of plagiarism and self-plagiarism contained in the Policy [Plagiarism: The use of the ideas or material of others without acknowledgement, or the re-use of one's own previously evaluated or published material without acknowledgement or indication thereof (self-plagiarism or text-recycling)]. I also understand that direct translations are plagiarism. Accordingly, all quotations and contributions from any source whatsoever (including the internet), have been cited fully. I understand that the reproduction of text without quotation marks (even when the source is cited), is plagiarism.

This thesis includes two original papers that will be submitted for publishing in peer-reviewed journals. The development and writing of the papers were the responsibility of the Masters student, Sharnay Botha. The co-author of the two articles, that form part of this thesis, Dr Eileen Africa (supervisor), hereby give permission for the candidate, Ms Sharnay Botha, to include the two articles as part of a Masters thesis. The contribution (advice and support) of the co-author was kept within reasonable limits, thereby enabling the candidate to submit this thesis for examination purposes. This thesis, therefore, serves as fulfilment of the requirements for the degree Master of Science in Sport Science at Stellenbosch University.

December 2019.

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SUMMARY

The growing sedentary lifestyles among today's school-going youth, have negative effects on their physical development and academic performance. Children need to move in order to learn and develop. During Grade 1, children experience a rapid increase in their motor and cognitive development. It is, therefore, important to establish healthy and active habits during this developmental period. This period (ages 5 to 7 years) is strongly related to improved academic performance, as well as the onset of perceptual-motor development. Perceptual-motor integration is important for both gross motor development and academic achievement.

The purpose of the current study was to improve the motor proficiency, letter recognition and -formation (reading and spelling) skills of selected Grade 1 children by implementing a perceptual-motor intervention and determining the relationships between these variables. The *Bruininks Oseretsky Test of Motor Proficiency-Second Edition Short Form* (BOT-2) was used to measure children's gross and fine motor proficiency; the *ESSI Reading and Spelling test* was used to test reading and spelling abilities and the *Beery-Buktenica Developmental Test of Visual-Motor Integration 6th Edition* (Beery VMI) was used to evaluate participants' visual-motor integration (VMI) skills. Two primary schools were selected through convenient sampling.

Two Grade 1 classes from each school were randomly selected and the learners were randomly assigned to an experimental (n=50) and control group (n=50). Of the total participants initially evaluated (N=100), 3 participants had to be excluded due to health reasons and non-attendance. Therefore, the final sample size was 97 (N=97), with 48 in the experimental group (n=48) and 49 in the control group (n=49). After pre-tests, the experimental group participated in a 12-week perceptual-motor intervention that consisted of two 60-minute sessions per week. The intervention focused on perceptual-motor skills, which included body awareness, spatial awareness, balance, visual perception and directional awareness and incorporated letters into the activities. After the 12-week intervention, participants underwent a post-test to measure the effects of the intervention. All data were statistically analysed by applying repeated measures ANOVA and Pearson correlations.

The results revealed that the 12-week perceptual-motor intervention was effective in significantly improving participants' overall motor proficiency, VMI, reading and

spelling skills. Results also indicated statistically significant positive correlations between motor proficiency, reading and spelling. Another finding revealed a significant improvement in participants' fine motor skills. As the intervention consisted of predominantly gross motor movements, it could be assumed that gross motor skills are essential for the development of fine motor skills.

This study provides unique contributions to the field of early childhood development investigating the relationship between gross motor development and academic performance. It provides sufficient evidence that gross motor movements can be beneficial for children's physical and academic skills.

Keywords:

Grade 1, Perceptual-motor development, motor proficiency, read, spell.

OPSOMMING

Die toenemende sedentêre leefstylpatrone onder vandag se skoolgaande jeug het negatiewe effekte op hulle fisieke ontwikkeling en akademiese prestasie. Kinders moet beweeg om sodoende te leer en te ontwikkel. Tydens Graad 1 ervaar kinders 'n vinnige toename in hul motoriese en kognitiewe ontwikkeling. Dit is daarom belangrik om gesonde en aktiewe gewoontes tydens hierdie ontwikkelingsperiode te vestig. Hierdie tydperk (ouderdomme 5 tot 7 jaar) toon 'n sterk korrelasie met verbeterde akademiese prestasie, asook met die aanvang van perseptueel-motoriese ontwikkeling. Perseptueel-motoriese integrasie is belangrik vir groot motoriese ontwikkeling en akademiese prestasie.

Die doel van die huidige studie was om die motoriese bedrewenheid, letter-erkenning en -formasie (lees en spel) vaardighede van Graad 1 leerlinge te verbeter deur middel van 'n perseptueel-motoriese intervensie en om die verhouding tussen die veranderlikes te ondersoek. Die *Bruininks-Oseretsky Test of Motor Proficiency-Second Edition Short Form (BOT-2)* is gebruik om die kinders se groot en fyn motoriese vaardigheid te bepaal; die *ESSI Lees en Speltoets* is gebruik om die kinders se lees- en spelvaardighede te toets en die *Beery-Buktenica Developmental Test of Visual Motor Integration 6th Edition (Beery VMI)* is gebruik om die kinders se visueel-motoriese integrasie (VMI) te evalueer. Twee laerskole is by die studie betrek deur van 'n gerieflikheidsteekproef gebruik te maak.

Twee Graad 1 klasse van elke skool is ewekansig gekies en die leerders is ewekansig aan 'n eksperimentele (n=50) en kontrole (n=50) groep toegeken. Van die totale groep deelnemers wat oorspronklik geëvalueer is (N=100), het 3 deelnemers uitgeval as gevolg van gesondheid redes en afwesigheid. Die finale steekproef grootte was dus 97 (N=97), met 'n eksperimentele groep van 48 (n=48) en kontrolegroep van 49 (n=49). Na die pre-toetse, het die eksperimentele groep aan 'n 12-week perseptueel-motoriese intervensie deelgeneem wat uit twee 60-minuut sessies per week bestaan het. Die intervensie het gefokus op perseptueel-motoriese vaardighede soos liggaamsbewustheid, ruimtelike bewustheid, balans, visuele persepsie en rigtinggewende bewustheid en het ook letters met aktiwiteite geïnkorporeer. Na die 12-week intervensie het deelnemers aan 'n post-toets deelgeneem om die effekte van die intervensie te bepaal. Alle data is statisties geanaliseer deur '*Repeated measures ANOVA*' en '*Pearson'* korrelasies toe te pas.

Die resultate toon dat die 12-week perseptueel-motoriese intervensie effektief was om deelnemers se motoriese vaardigheid, VMI en lees en spel statisties beduidend te verbeter. Die resultate het ook aangedui dat daar statisties beduidende positiewe korrelasies tussen motoriese vaardighede, lees en spel was. Nog ’n bevinding toon dat daar ’n statisties beduidende verbetering in die deelnemers se fyn motoriese vaardighede was. Omdat die intervensie oorwegend bestaan het uit groot motoriese vaardighede, kan aangeneem word dat groot motoriese vaardighede belangrik is vir die ontwikkeling van fyn motoriese vaardighede.

Hierdie studie lewer ’n unieke bydrae tot die studieveld van vroeë kind ontwikkeling en navorsing oor die verhouding tussen groot motoriese ontwikkeling en akademiese prestasie. Dit bied ook voldoende bewyse dat groot motoriese bewegings voordelig vir kinders se fisieke en akademiese vaardighede is.

Sleutelwoorde:

Graad 1, Perseptueel-motoriese ontwikkeling, motoriese vaardigheid, lees, spel.

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LIST OF ABBREVIATIONS

VMI	Visual motor integration
Beery VMI	Beery-Buktenica Test for Visual Motor Integration
BOT-2	Bruininks Oseretsky Test of Motor Proficiency-Second Edition
SAPIK	South African Professional Institute for Kinderkinetics
SD	Standard deviation
REC	Research Ethics Committee
WCED	Western Cape Education Department
FMS	Fundamental Motor Skills
IRR	Institute of Race Relations
SSA	Statistics South Africa
PE	Physical Education
HAKSA	Healthy Active Kids South Africa
FM	Fine Motor

CHAPTER 1
PROBLEM STATEMENT

Referencing within the chapter and the list of references at the end thereof has been done in accordance with the guidelines of the Department of Sport Science, Stellenbosch University.

INTRODUCTION

Sedentary lifestyles often cause poor fundamental movement skills (FMS) and lower academic performance in children (O'Dwyer *et al*., 2012:117). Schools, traditionally a place of formal learning, are where children mostly exhibit sedentary behaviour (Norris *et al*., 2015:117). Physical activity and movement are vital parts of a child's normal physical and cognitive development (Piaget, 1962:6) and are believed to influence the development of problem-solving skills, critical thinking, language acquisition and creativity (Burriss & Tsao, 2012:230). The early developmental period is, therefore, critical for a child to establish healthy and active habits (Carson *et al*., 2015:115). Movement should be an integral part of learning because children learn best through movement and active involvement (Samuelsson & Carlsson, 2008:624).

Research has shown that well-developed motor proficiency facilitates a child's cognitive functioning, especially his or her academic performance in reading, language and mathematics (Westendorp *et al*., 2011:2773; Ericsson & Karlsson, 2012:273; Pienaar *et al*., 2013:371; Da Silva Pacheco *et al*., 2016:967; Cadoret *et al*., 2018:150). Motor proficiency is defined as the ability to perform gross and fine motor skills in a consistent and proficient manner (Kaiser *et al*., 2009:87). It involves the development of movement sequences and motor control to produce complex motor skills by combining both gross and fine motor skills (Pienaar *et al*., 2013:375).

Academic performance in the first year of school is often measured in terms of the quality of a child's handwriting, reading and spelling (Richmond & Taylor, 2014:2). These are all cognitive processes that require well-developed perceptual-motor and motor proficiency skills (Bara & Gentaz, 2011:746). An important aspect of academic performance, specifically in reading and spelling, is visual perception (Kaiser *et al*., 2009:89; Ohl *et al*., 2013:507). Producing legible writing is a complex task for young children, because it requires the coordination of cognitive, motor and sensorimotor processes (Vinter & Chartrel, 2009:476; Dinehart, 2015:99). Reading and spelling requires the ability to recognise the visual symbol of a letter to guide construction (letter recognition), as well as knowledge of the specific motor patterns each letter consists of (letter formation) (Bara & Gentaz, 2011:746; Brown & Link, 2015:164). Letter recognition and letter formation are essential skills for reading and spelling performance (Weintraub *et al*., 2009:125). The learning of letters and writing is highly dependent on the child's ability to integrate visual perception and motor skills (Capellini

et al., 2017:259). This process is known as visual-motor integration (VMI) which is imperative for a child to be able to copy letter forms (Pagani & Messier, 2012:97; Pienaar *et al*., 2013:371; Dinehart, 2015:99). VMI is also an important skill for gross motor development. Skills such as hand-eye coordination depend on well-developed VMI skills as it allows the child to focus on the object and coordinate his or her limbs to perform the desired action (Du Plessis *et al*., 2015:70).

A very important skill for the foundation of academic achievement and motor proficiency, is perceptual-motor skills (Pienaar, *et al*., 2011:114; Hejazi *et al*., 2013:3; Erasmus *et al*., 2015:597). Perceptual-motor integration is the process of recognizing and interpreting sensory information obtained from the environment. It refers to the child's ability to interact with the environment, using both their senses and motor skills for interpretation (Erasmus *et al*., 2015:597). Learners will progress more effective through school and have a strong foundation for later reading and writing if they have developed their perceptual-motor skills properly (Loubser *et al*., 2016:54).

PROBLEM STATEMENT

The foundation of children's reading and writing performance is perceptual-motor skills (Hajezi *et al*., 2013:2). Research also suggests that there is an association between increased physical activity and improved academic performance (Ericsson & Karlson, 2012:274). Despite this, modern day schools remain mostly sedentary where 5 to 6 hours per day are spent seated behind a desk (Carson *et al*., 2015:115), which has a negative effect on children's overall development (O'Dwyer *et al*., 2012:117). Therefore, the current study aimed to determine the effect of a perceptual-motor intervention on selected Grade 1 children's motor proficiency and letter knowledge.

AIMS AND SUB AIMS

Primary Aim

The primary aim of the current study was to investigate the effect of a perceptual-motor intervention on the motor proficiency, letter recognition and letter formation of selected Grade 1 children.

The sub aims of each article (Chapter Four and Five) were as follows:

Research article one (Chapter Four):

To determine the effect of a perceptual-motor intervention on the letter knowledge (letter recognition and – formation), of selected Grade 1 children.

Research article two (Chapter Five):

To determine the relationship between motor proficiency and letter knowledge of selected Grade 1 children after participation in a perceptual-motor intervention.

HYPOTHESIS

Research hypothesis (H_1): The perceptual-motor intervention had a statistically significant effect on the motor proficiency, letter recognition and -formation of selected Grade 1 children.

Null Hypothesis (H_0): The perceptual-motor intervention had no statistically significant effect on the motor proficiency, letter recognition and -formation of selected Grade 1 children.

RESEARCH QUESTION

Will a perceptual-motor intervention have a statistically significant effect on the motor proficiency, letter recognition and -formation of selected Grade 1 children?

METHODOLOGY

Research design

A quasi-experimental research design was used in the current study, because the participating schools were not randomly selected. This study design was used to test cause and effect relationships between the variables. Quantitative data were collected before and after the intervention. The effects of the intervention were measured by dividing the subjects randomly into a control group, who did not take part in the intervention, and an experimental group, who did participate in the intervention.

Sampling technique

Because of the proximity of the schools, a sample of convenience was used to select two schools. The two schools were readily accessible to the researcher and were selected from the Stellenbosch (School A) and Bellville (School B) areas in the Western Cape. The sample groups in each school were selected according to

homogenous purposive sampling, because the study's main aim was to determine the effect of a perceptual-motor intervention on Grade 1 children. In each school, there were four Grade 1 classes available to participate in the current study. The school administrators randomly selected two Grade 1 classes from each school (N=100). Classes were then randomly assigned to the control and experimental groups by an independent third party. One class from each school formed the control group and one class from each school formed the experimental group. The experimental group participated in the perceptual-motor intervention, while the control group continued with their ordinary school programme. The control group will take part in the programme after completion of the study and the intervention programme will be shared with the participating schools to implement afterwards. School A (N=62) consisted of 30 participants in the experimental group (n=30) and 32 in the control group (n=32). School B (N=38) consisted 20 participants in the experimental group (n=20) and 18 in the control group (n=18). After the post-test, 2 participants were excluded from the experimental group because of health reasons and 1 child was excluded from the control group because of non-attendance (N=97).

Assessments

Standardised tests and assessments were used to collect data from the participants. The first two weeks of the intervention included pre-tests and the last two weeks post-tests. All assessments were done by qualified Kinderkineticists and Kinderkinetics Honours students. All the assessors were trained by the main researcher and qualified to perform the tests included in this study. The Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2), was used to assess motor proficiency (Bruininks & Bruininks, 2005:2); the Beery-Buktenica Developmental Test of Visual-Motor Integration (Beery VMI) was used to assess participants' Visual-Motor Integration (VMI) skills (Beery & Beery, 2010:10) and the ESSI Reading and Spelling Test was used to assess the children's letter recognition (reading) and formation (writing and spelling) skills (Esterhuyse, 2002:1).

Intervention

The 12-week perceptual-motor intervention was planned by the main researcher who is a qualified Kinderkineticist (01/017/11/1718/005), registered at the South African Professional Institute for Kinderkinetics (SAPIK). Kinderkinetics is a professional field

focusing on the total well-being of children aged 0 to 12 years. Scientifically based and prescribed exercise programmes are used to promote the psychomotor, physical and neuro-motor development of children. The word 'Kinderkinetics' can be broken up into 2 parts, 1) 'Kinder', which refers to the area of specialisation (children aged 0-12 years) and 2) 'Kinesis', which refers to movement. The aim of Kinderkinetics is, therefore, to optimize the overall development of a child through gross motor movement (Pienaar, 2009:50).

The intervention focused primarily on perceptual-motor skills and incorporated letters and words into the activities. The intervention occurred twice a week for 60 minutes per session. Participants were divided into 3 groups in which they stayed for the entire intervention period. Each group had a presenter who remained with them throughout every session for the entire duration of the intervention. This was to ensure consistency throughout the intervention. Every session consisted of a 7-minute proprioception stimulation exercise, followed by an 8-minute warm-up, 4 activities (each consisting of 10 minutes each), and a 5-minute cool down. A detailed description of the intervention programme, the selected equipment used and pictures from the intervention are presented in Appendix H-K.

Data analysis and interpretation

Data was analysed by Professor Martin Kidd, Director of the Statistical Consultation Centre at Stellenbosch University and Statistica®, version 13.5.0.17, was used. Repeated measures ANOVA was applied to examine the effects of the intervention on the variables of the current study. The participants were included as random effect and group (experimental or control) and time (pre- or 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 (SD) were reported and a 95% ($p<0.05$) confidence interval was used as guideline for significant results. Pearson correlations were used to investigate relationships between the ESSI Reading and Spelling variables and the BOT-2 variables.

Ethical considerations

Ethical clearance was obtained from the Research Ethical Committee (REC) of Stellenbosch University (REC-2018-7126). Only after permission was granted from

both the Western Cape Education Department (Appendix L), and REC of Stellenbosch University (Appendix M), the study commenced. Consent was obtained from the parents (Appendix C & D) and permission from the children was obtained by means of an assent form (Appendix E & F). Children were under constant supervision by more than one supervisor throughout the entire duration of the intervention.

All data was handled as confidential and stored on the researcher's and study leader's computers and external hard drives, which is stored securely. Laptops are password protected and the specific folders are also secured. Hard copies are safely stored in a safe at the Department of Sport Science. No information will be shared to any other person or the public.

LIMITATIONS

The following limitations of the current study were identified:

- The sample was obtained through convenient sampling because of financial and logistical reasons, which minimizes the generalizability of the study.
- There is limited research on the impact of physical activity on academic performance.
- The sample size was small (N=97) as it only included two schools in the Western Cape area, which makes it difficult to generalize results to other parts of South Africa or other countries.

STRUCTURE OF THE THESIS

The thesis is presented in research article format. The two research articles (Chapters Four and Five), were written according to the specific journal guidelines. Therefore, the formatting referencing style used throughout the thesis will differ.

Chapter One: Problem statement

This chapter summarizes the problem statement, aims, objectives and methods used in the current study. The adapted Harvard reference style was used in this chapter in accordance with the guidelines set out by the Department of Sport Science, Stellenbosch University.

Chapter Two: Theoretical context

The purpose of this chapter was to provide background that relates to the study, which include childhood development, perceptual-motor integration, VMI, motor proficiency and academic performance. The chapter also aims to explain the relationship between each of these variables. The Harvard reference style was used in accordance with the guidelines set out by the Department of Sport Science, Stellenbosch University.

Chapter Three: Methodology

This chapter is included to give a summary of all the methodology used in the current study. The research design, sampling method, evaluation tools, intervention procedures and data analysing methods are explained. This adapted Harvard reference style was used in accordance with the guidelines set out by the Department of Sport Science, Stellenbosch University.

Chapter Four: Research Article 1

The title of research article 1 is, *The effect of a perceptual-motor intervention on the letter knowledge of selected Grade 1 children*. This chapter is included herewith in accordance with the journal guidelines of Perceptual and Motor Skills (Appendix A). The American Psychological Association (APA) reference style was used. This article has been submitted for publication and the researchers are waiting for feedback.

Chapter Five: Research Article 2

The title of research article 2 is, *The effect of a perceptual-motor intervention on the relationship between motor proficiency and letter knowledge*. This chapter is included herewith in accordance with the journal guidelines of Developmental Science (Appendix B). The APA reference style was used. This article has been submitted for publication and the researchers are waiting for feedback.

Chapter Six: Conclusions, Recommendations & Limitations

This chapter summarizes and concludes all the important findings of the current study. The recommendations for future studies are discussed and limitations of the current study highlighted. The adapted Harvard reference style was used in accordance with the guidelines set out by the Department of Sport Science, Stellenbosch University.

SUMMARY

This chapter has briefly outlined the importance of physical activity for Grade 1 children's academic performance and gross motor development. The main aim and objectives of the current study and each research article were also stated to form a hypothesis to determine whether the intervention was effective in improving children's motor proficiency, letter recognition and -formation.

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CHAPTER 2

THEORETICAL CONTEXT

Referencing within the chapter and the list of references at the end thereof has been done in accordance with the guidelines of the Department of Sport Science, Stellenbosch University.

INTRODUCTION

The early elementary years are critical for a child's overall development (Hardy *et al*., 2010:503). Between the ages of 5 to 10 years, children experience a rapid increase in their motor and cognitive development (Roebers & Kauer, 2009:175). Unfortunately, physical activity in schools is not seen as a priority due to the increasing demands on academic performance (Lu & Montague, 2016:410; Bartholomew *et al*., 2018:52). Therefore, most children spend the majority of their school day performing sedentary activities, contributing to problems with overall health and academic performance (Donnelly & Lambourne, 2011:52; O'Dwyer *et al*., 2012:117). However, recent evidence suggests that the combination of movement and learning is an effective way to promote physical activity and academic performance (Bartholomew & Jowers, 2011:53; Donnelly & Lambourne, 2011:52; Norris *et al*., 2015:117; Mullender-Wijnsma *et al*., 2016:3). If children are allowed the opportunity to be physically active during school time, it will be beneficial for their overall motor development, as well as their academic and social skills (Hardy *et al*., 2010:503).

Childhood development

Early childhood, which is approximately between the ages of 2 to 7 years, is an ideal period where children develop fundamental movement skills (FMS) (Bardid *et al*., 2013:4572), as well as perceptual-motor skills (Westendorp *et al*., 2011:2773). This is due to children being more susceptible to learning during this stage as well as having more underdeveloped motor skills. These skills, therefore, do not interfere with their ability to learn new, more complex skills. Children are also more inquisitive and eager to learn new skills at this stage. Their muscles, skeleton and joints at this age are still growing and their habits and skills acquired during this age are more long-lasting (Sajedi & Barati 2014:14). By the age of seven, children are expected to have acquired an adequate level of competence, as they enter a more sport specific period (Bardid *et al*., 2013:4572).

The development of all children follows a natural pattern and order. There are various models and theories explaining the pattern and order of child development that will be discussed below:

According to Clark & Metcalfe (2002:9), five motor development phases classify a child's normal development. The following phases of motor development can be

classified, namely: the reflexive phase (birth to 2 weeks old); preadapted phase (2 weeks to 1 year old); fundamental motor patterns (1 to 7 years old); context-specific phase (7 to 11 years old); and the skilful phase (11 years and older) (Clark & Metcalfe, 2002:11-20). The reflexive movement phase involves observable involuntary movement activity and is essential for survival as well as cognitive and motor development. The second phase of Clark and Metcalfe's model is known as the preadapted phase, which refers to the emergence of voluntary movements and inhibition of reflexes (Clark & Metcalfe, 2002:14). The next phase is the fundamental patterns phase, wherein FMS are developed. Children in Grade 1 fall under the fundamental motor patterns phase (Pienaar, 2017:8) which builds upon previously learned movements from the previous phases (Clark & Metcalfe, 2002:15). This phase prepares the child for skills and movements that are more advanced (O'Brien *et al*., 2016:558). Clark and Metcalfe (2002:16) explain that FMS represent the "base camp" from which children will develop up the mountain of motor development to progress through the other phases. This is the phase wherein individual constraints has an influence on the developmental patterns or rate that children progress through the rest of the mountain. FMS are considered to be the building blocks of more specialized and complex movement sequences required for sports and other physical activities (Clark & Metcalfe, 2002:16; Gallahue & Ozmun, 2006:6). The skills involve combined motor patterns of two or more body sections and can be further classified under locomotor, manipulation and stability skills (Goodway *et al*., 2012:19; Goodway *et al.*, 2014:46). Locomotor skills involve any movement that allows one to move from one point to another and examples of this includes running, jumping, hopping, leaping, sliding, galloping and skipping. Manipulation, or object control, skills involve any manipulation of an object, such as a ball or bat. Examples of object control skills include throwing, catching, kicking, punting, striking, rolling, and bouncing. Stability skills involve balance in static and dynamic positions (Goodway *et al*., 2012:19). As a child becomes more proficient in his or her FMS, it build the foundation to learn more specialized movement sequences, enabling children to participate in various types of sport (Clark & Humphrey, 2002). Next, children will move into the context-specific period, which is when children start to apply their FMS in daily tasks and sport activities. They are able to expand their movement repertoire and start combining and adapting basic FMS in new and different movement situations. The last phase, known as the skilfulness phase, is when children achieve skilful behaviour. This occurs when

children have acquired sufficient experience and practice and is, therefore, not achieved by all children. Only those who have achieved a certain level of proficiency in their FMS will reach this period. Therefore, both individual constraints and environmental influences will affect the child's ability to reach this phase (Clark & Metcalfe, 2002:16).

Gallahue's Hourglass Model of Motor Development (Gallahue, 1998) is similar to the Mountain of Motor Development (Clark & Metcalfe, 2002) and emphasises three factors, namely: individual features; environment and task; and understanding movement and different stages of development. He compared children's motor development with an hourglass, consisting of the following phases: Reflexive movement phase, Rudimentary movement phase, Fundamental movement phase, and specialized movement phase. Each phase is made up of different stages and the ages for each phase and stage depends on environmental influences as well as the genetic structure of the individual. The 'falling sands' of the hourglass model describes that the development of an individual depends on both hereditary and environmental factors. As the sands fall, they build the phases and stages of the motor development across the individual's lifespan. The first phase of Gallahue's hourglass model is the reflexive movement phase. This phase is further divided into the information encoding (utero to 4 months old) and decoding (4 months to 1 year old) stages and is marked by involuntary movements. The second phase, the rudimentary movement phase, is made up of the reflex inhibition stage (birth to 1 year) and pre-control stage (1 to 2 years). This phase is known for including the first forms of voluntary movements and is categorized by a highly predictable sequence of appearances. These movements are the basic form for more advanced movements later in life and include basic stability, locomotor and manipulative movements. The reflex inhibition stage involves the inhibition of several primitive reflexes to allow for voluntary movement development. However, movements during this stage still seem very uncontrolled and uncoordinated. During the pre-control stage, children start to gain more control and precision over their movements and they are able to differentiate between different sensory and motor systems. Children also develop the ability to maintain equilibrium, manipulate objects and navigate through their environment during this stage. The third phase is known as the fundamental movement phase which consists of the initial (2 to 3 years), elementary (4 to 5 years) and mature (6 to 7 years) phases. This also

includes locomotor, manipulation and stability skills. The initial stage represents the first goal-directed attempt at performing a certain fundamental skill and movements are improperly sequenced, restricted or exaggerated and poorly coordinated. During the elementary stage, children gain more motor control and rhythmical coordination of their movements. The mature, or proficient stage, is characterised by mechanically efficient and coordinated movements and execution of the fundamental skills. The final phase is called the specialized movement phase, consisting of the transitional (7 to 10 years), application (11 to 13 years) and lifelong utilization (14 years and older) stages. In this phase the fundamental movement skills become refined and combined for use in daily living, physical activity or sports. Children start to combine and apply fundamental skills in sport and recreation when they reach the transitional stage. During the application stage, children start to apply more cognitive strategies and have a broader experience base. The lifelong utilization stage continues through adulthood and the experiences and decisions made during the previous stages are carried over into this stage (Gallahue & Donnelly, 2003:37; Gallahue & Ozmun, 2006).

Another model of motor development, known as Stodden's Spiral of Engagement-Disengagement Model (Stodden *et al.,* 2008:293-298) explains that there is a reciprocal relationship between motor competence and physical activity. This model suggests that the relationship between these two variables strengthen as the individual develops. Moreover, the model explains that children's physical activity during early childhood forms the foundation for development of motor skill proficiency by means of FMS acquisition. The more skilled children are in their FMS, the higher their physical activity levels are expected to be, while the less skilled children will choose to participate in less physical activity. Similar to Clarke and Metcalfe's Mountain of Motor Development (Clark & Metcalfe, 2002:16), Stodden *et al.,* (2008:294) also emphasizes that all children will follow different developmental trajectories in moving through the different developmental phases based on individual and environmental constraints. Stodden also acknowledges that the following mediating variables will also have an influence on motor competence; perceived motor skill competence, health-related physical fitness, and obesity. Each of these variables will either increase or decrease physical activity levels and motor competence. A positive spiral of engagement occurs when children have moderate or high motor competence, high perceived motor competence, and high levels of physical activity and fitness. This results in greater

physical activity levels, healthy weight and higher fitness levels. A negative spiral of disengagement has the opposite effect, wherein lower levels of motor competence, perceived competence, physical activity and fitness results in lower physical activity levels and fitness and unhealthy weight or obesity. Therefore, it is important to establish a strong foundation of FMS during early childhood, to ensure motor competence and lifelong participation in physical activity (Clark & Metcalfe, 2002:20; Stodden *et al.,* 2008:298).

Although children naturally progress through different phases and stages as a result of maturation, in order to master these skills they need to practice and participate in structured activities to further develop their skills. Seefeldt (1980) introduced a term known as the proficiency barrier, which explains that children need a certain level of competence in their locomotor, object control and stability skills to be able to apply them in sports, games and other recreational activities. Therefore, it is critical to develop children's FMS skills in order for them to remain physically active throughout their childhood and into adulthood. A child's overall development can be affected if delays occur in the fundamental movement phase (Roebers *et al*., 2014:285). By developing proficient FMS, it establishes a foundation for optimal physical, cognitive and social development as well as for an active and healthy lifestyle (Stodden *et al.,* 2008:291; Hands & McIntyre, 2015:1). This is because motor deficits acquired during this period have an influence on a child's learning abilities (Pienaar *et al*., 2011:114). It is, therefore, important to monitor their development in order to identify and treat possible difficulties early on (Gligorovic *et al*., 2011:407). The basic movement patterns acquired during the fundamental movement phase are not developed naturally during the maturation process (Hardy *et al*., 2010:504). Appropriate activities need to be structured and implemented by trained movement therapists and practitioners, providing opportunities for children to learn and receive constructive feedback (O'Brien *et al*., 2016:558). The attainment of fundamental movement skills (FMS) is important as it allows the children's movements to become more skilful and coordinated. Their improved motor proficiency allows more opportunities to explore, learn and interact with their environment (Cadoret *et al*., 2018:150). Only after children have obtained FMS, will they be able to apply their basic motor skills in other areas, such as in sport (Draper *et al*., 2011:137; Logan *et al*., 2011:305). Barnett and colleagues (2008:8) explained that proficient object control skills are strongly related

to improved sport competence and, thereby, positively influences lifelong physical activity and fitness. Moreover, proficient object control are also positively associated with academic performance in reading, spelling and mathematics.

Physical development

Physical development is imperative for a child's overall development because it lays the foundation for all the other systems. Any delay may affect their emotional, social and cognitive development (De Jager, 2014:16). De Jager and Victor (2017:11) explain that a child's development can be compared to a house (Figure 1), consisting of the foundation (physical development), walls (emotional development), windows (social development) and, lastly, the roof (cognitive development). These different parts develop in a certain order and each stage only develops after the previous stage is well established (De Jager, 2014:32).

The foundation of the house is the child's physical development, which develops first. This is made up of the neural network that connects the brain to the senses and muscles. It includes the senses, movements and perception. Once the sensory system is developed, the development of gross motor skills, balance, coordination, fine motor skills, midline crossing and lastly body and spatial awareness can occur (De Jager, 2014:32). Ayers' sensory integration theory states that sensory integration involves the organisation of sensory input in order to utilise this information (Ayres & Robbins, 2005:3). Dr Ayres (Ayers & Robbins, 2005:5) states that "sensory integration forms the underlying foundation for academic learning and social behaviour". If the child is unable to accurately process sensory information, it will affect their ability to perform daily tasks and other skills such as motor and academic skills (Ayers & Robbins, 2005:8). After a firm physical development foundation is established, the child's emotional (walls of the house) and social skills (windows), such as emotional and impulse control, develop. Thereafter, the child's cognitive skills begin to develop, which is represented by the roof of the house. The child can only access their cognitive skills once his or her physical, emotional and social development has been well-developed. The more children move, the stronger the connection between their brain and body (De Jager & Victor, 2017:11-14). It is, therefore, important to ensure that children's physical development is well-established before cognitive skills are introduced (De Jager, 2014:11).

The 'House of Child Development' can further be supported by the Dynamic Systems Theory. This theory states that learning occurs due to an interaction of multiple systems within the person, task and environment. These systems interact with each other to produce the most efficient movement for a specific task. When a child learns a new motor skill, it is important to consider all three systems affecting it (Thelen 1989:947). This theory also states that tasks requiring vision and ocular motor abilities, such as reading and spelling, are not foundational skills. They are a part of the complex interaction of different components. These components include tactile awareness, proprioception, movement, attention and knowledge. Each of these components affects and is affected by each other (Cote, 2015:158). Furthermore, Smith & Thelen (2003:347) stated that during development every time a new skill is learned, it creates a foundation for the next skill. This is similar to the 'House of Child Development' as it emphasizes that one phase or skill needs to be established for the next phase or skill to develop. Furthermore, both theories highlight that children develop holistically over a period of time.

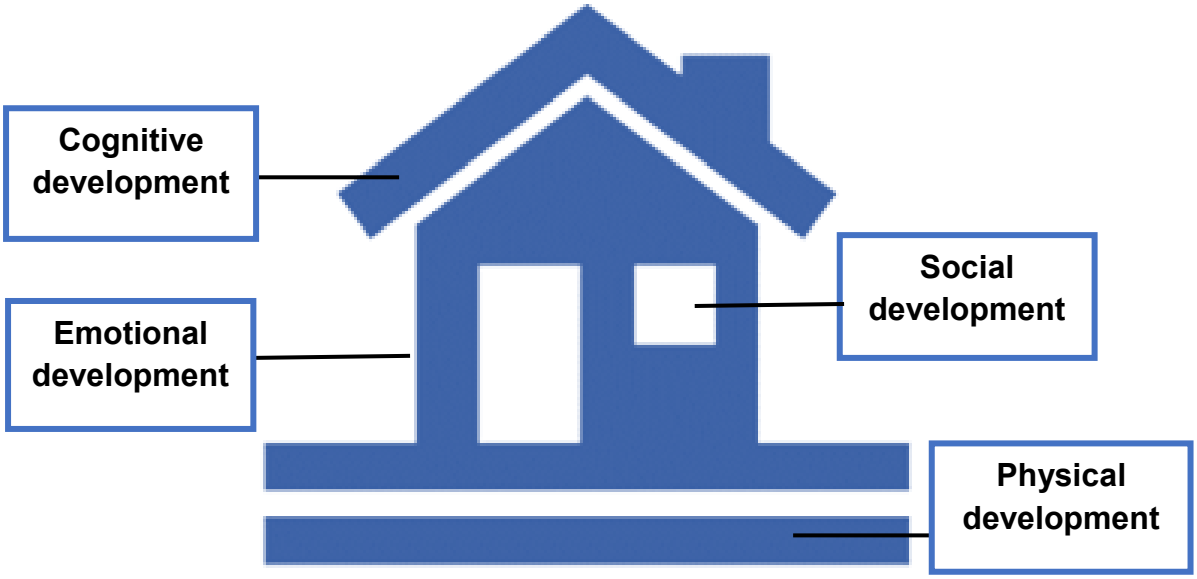

FIGURE 1: **THE HOUSE OF CHILD DEVELOPMENT.**
Adapted from: De Jager & Victor (2017:11).

PERCEPTUAL-MOTOR INTEGRATION

Sajedi and Barati (2014:14) states that one of the most important aspects for children to develop is perceptual-motor integration as it is essential for the development of children's cognitive, affective and psychomotor domains. According to Adolph and Kretch (2015:127), "perceptual learning is the key to knowledge and where it all

begins". Therefore, perception forms the foundation for developing cognition and other motor skills (Adolph & Kretch, 2015:127).

Perception refers to the process of receiving, organizing and interpreting sensory information. Perceptual-motor integration is the process of recognizing and interpreting the sensory information obtained from the environment. It refers to the child's ability to interact with the environment, integrating both their senses and motor skills for interpretation (Frost *et al*., 2012:56; Erasmus *et al*., 2015:597). Perceptual information is obtained from the six sensory systems, namely: visual; auditory; tactile; kinaesthetic; taste; and smell, which is then combined with gross and fine motor skills (Pienaar, 2017:193).

All movement involves perceptual-motor integration because of the sensory stimulation obtained from the environment (Pienaar *et al.*, 2011:114). Although movements largely depend on coordinating and controlling physical forces, managing these forces requires processes that are more complex. Perception is an important process required to plan and guide one's movements. Movement, in turn, allows perceptual information to be obtained and provides the means for obtaining knowledge from the environment (Adolph & Kretch, 2015:127; Cadoret *et al*., 2018:150).

Several studies have shown that a child's perceptual-motor skills are essential for cognitive development and for acquiring academic knowledge and skills, such as reading and writing (Gligorovic *et al.*, 2011:421; Lobo *et al*., 2013:95; De Waal *et al*., 2018:967). Previously, cognition was believed to be unaffected by perceptual-motor experiences (Lobo *et al*., 2013:95). However, new theories and evidence explain that the perceptual-motor experience actively form, maintain and modify cognition (Lobo *et al*., 2013:95). As the perceptual-motor functions mature, the higher order functions also mature (Gligorovic *et al.*, 2011:421). Therefore, it is important to explore how perceptual-motor skills relate to handwriting and reading and how these skills may be improved.

Perceptual-motor skills

Perceptual-motor skills require the combination of sensory stimulation with gross and fine motor skills (Hyatt *et al*., 2009:314). The perceptual-motor process involves obtaining a sensory input that is integrated and converted into a motor output (Johnstone & Ramon, 2011:1; Pienaar *et al*., 2011:114). Perceptual-motor skills can

be classified into the following categories: body awareness; spatial awareness; directional awareness; tactile perception; temporal awareness; and visual perception (Pienaar *et al*., 2011:114; Frost *et al*., 2012: 58; Kersey & James, 2013:1; Elena *et al*., 2014:633).

Body awareness and spatial awareness

Body awareness is known as the inner awareness of the body and its different parts (Cheatum & Hammond, 2000:85). Children begin to develop body awareness at the age of two and then later become more aware of their body parts in relation to other objects in their environment (Elena *et al*., 2014:633). Body awareness implies an understanding where the body is in space and consists of three main components, namely: body image; body schema; and body concept. Body image is related to how a child feels about him-/ herself and involves self-confidence. Body concept is the ability to identify the different body parts and usually develops from cephalocaudal to proximodistal. Lastly, body schema can be defined as the internal awareness of where the different body parts are in relationship to each other (Cheatum & Hammond, 2000:85-96). In order for children to move their limbs accurately and in a coordinated way, they have to have an internal sense of their body and its parts and how they move (Mehling *et al*., 2011:1, 2). The more children move, the more information they gain from their bodies and the more they learn what their bodies are able to do (Elena *et al*., 2014:633).

Spatial awareness can be defined as the perception of the body's position and orientation in space in relationship with other objects and is associated with body awareness (Elena *et al*., 2014:633; Pienaar, 2017:44). It is an important perceptual-motor skill to develop for academic tasks involving fine motor skills (Cameron *et al*., 2016:94).

Directional awareness

Another important perceptual-motor skill for academic achievement is directional awareness (Richmond & Taylor, 2014:4), which refers to the ability to distinguish between the different sides of the body and of other objects (up, down, left, right, in front & behind). It includes components, such as laterality, directionality, lateral preference and midline crossing (Pienaar, 2017:195). It is an important skill to develop

for the correct orientation of letters, as well as for fluent reading (Richmond & Taylor, 2014:2).

Laterality is the inner awareness that the body has two sides and the ability to distinguish left from right (Tichy & Belacek, 2009:10). It is necessary for the child to develop this skill because it allows him or her to use either one or both sides of the body to perform an action. Development of laterality gives the child the ability to use the two different sides of the body either together or to perform opposite tasks (Cheatum & Hammond, 2000:85-96). An important academic skill that requires this ability, is writing, because the child has to hold the paper with one hand and use the other hand to write. Laterality is also an important skill required for gross motor activities involving the use of one or both sides of the body to perform any movement in a coordinated way. Once children are able to distinguish between the left and right sides of their own bodies, they will be able to project the knowledge of left and right to other objects and people (Cheatum & Hammond, 2000:85-96).

Directionality is the ability to project laterality into space, thereby distinguishing the different sides of an object (Cheatum & Hammond, 2000:85; Picard, 2011:26). It involves three references, namely: right and left; up and down; and in front and behind. If a child has laterality or directionality problems, he or she will find it difficult to read from left to right and struggle with letter reversals (Richmond & Taylor, 2014:2). Directionality should be fully developed by the age of 7 (Cheatum & Hammond, 2000:85-96; Picard, 2011:26). Moreover, directionality and laterality are only established after body awareness is well-developed. The mental picture children form of their bodies help them to recognize where they are in space in relation to other objects and people (right, left, in front, behind, top and bottom). It is important for the child to have developed this skill in a three-dimensional world first before applying it to two-dimensional tasks such as reading and writing (Sherry & Draper, 2013:1303).

By the time that children are in Grade 1, they should have developed lateral preference, which is the child's preferred and dominant hand, foot or eye. A child who has not developed lateral preference often struggles to cross their body's midline. Midline crossing is observed when an individual reach across the body's midline to the opposite side of the body (Scharoun & Bryden, 2014:7). Failure to cross the midline will interfere with many of the child's academic tasks, such as sitting still while writing (Cheatum & Hammond, 2000:105). If a child cannot cross the body's midline while

performing gross motor movements, such as when reaching one arm to the opposite side of the body, he or she will also not be able to cross the midline with their eyes. When reading from left to right, the eyes must cross the midline. However, the child's eyes will 'jump' as soon as the eyes reach the middle and the child will lose his or her place while reading (Scharoun & Bryden, 2014:7).

Tactile perception

Tactile perception involves a touch sensation received from the environment. There are different forms of touch, which include cold, hot, pain, soft or hard. Proprioception is a component related to tactile perception and offers the sensation felt when muscles and joints are stimulated by different movements and muscle contractions (Yunus *et al*., 2015:3566). According to Gligorovic *et al*. (2011:407), tactile awareness and proprioception are important for the foundation of children's higher cognitive functions. Without it, children will not be able to have the sensation of their movements or be able to control and guide them (Yunus *et al*., 2015:3566).

Temporal awareness

Temporal awareness is strongly related to spatial awareness (Elena *et al*., 2014:633). It can be defined as the ability to distinguish between long and short periods, between different rhythms, as well as between fast and slow. It is the process of having the sense of timing within the body. It is also an important skill for correct synchronization and timing of movements for both fine and gross motor skills (Elena *et al*., 2014:633).

Visual perception

An important aspect of academic performance is visual perception (Kaiser *et al*., 2009:89; Ohl *et al*., 2013:507). The learning of letters and writing is highly dependent on the child's ability to integrate visual perception and motor skills (Capellini *et al*., 2017:259). Visual perception involves obtaining visual information from one's surroundings and integrating this information with past experiences and higher cognitive functions (Brown & Link, 2015:164). It is important for handwriting, because it involves the ability to compare similarities and differences in forms, as well as to copy lines and shapes (Van Hoorn *et al*., 2010:941). Visual perception is used to form an internal representation of the shape, size, position and distance of letters. Without it a child will not be able to correctly recognize, identify and form letters and words (Capellini *et al*., 2017:259).

Sub-components of visual perception include: depth perception, which is the ability to judge relative distance; form perception, which involves recognizing and identifying shapes, symbols, letters; and figure-background discrimination, which is when one can distinguish an object from its background. Other sub-components include spatial perception, form constancy, visual memory, sequential processing, visual closure and visual-motor integration (VMI) (Pienaar, 2017:194).

Visual-motor integration

VMI can be defined as the ability to integrate visual, perceptual and motor skills (Coetzee & Du Plessis, 2013:37). It is the process whereby visual-spatial information is integrated with fine-motor skills to produce coordinated motor tasks (Pienaar *et al.*, 2013:371; Du Plessis *et al*., 2015:69; De Waal *et al*., 2018:968). VMI is seen as one of the most significant perceptual-motor components that relates to reading, writing and spelling (De Waal *et al*., 2018:967). It involves the ability to coordinate the hands and eyes and, therefore, is an important skill to master for reading and writing achievement (Capellini *et al*., 2017:258).

The motor aspects of VMI is required for the proper coordination and sequencing of movements to produce the letter (Capellini *et al*., 2017:259). The ability to effectively decode written words requires well-developed VMI skills in children (Bellocchi *et al*., 2017:296). Bellocchi *et al*. (2017:303) concluded in their longitudinal study that VMI is an effective measurement to predict handwriting and reading performance. Therefore, it can be assumed that VMI is a key contributing skill in reading and writing development (Bellocchi *et al*., 2017:303).

A child with well-developed VMI will display legible handwriting, skilful construction and the ability to complete visual or motor activities accurately and effectively (Emam & Kazem, 2014:549). If a child experience problems with VMI, it might be either because of visual perception problems, motor skill problems, or difficulty with integrating the visual and motor aspects of VMI (Capellini *et al*., 2017:259). Signs that demonstrate problems with VMI include messy handwriting, inability to form or accurately copy letters and shapes, perform motor activities at a slow speed and difficulty with building puzzles (Emam & Kazem, 2014:549).

VMI is also an important skill for gross motor development (Du Plessis *et al*., 2015:70). Skills such as hand-eye coordination depend on well-developed VMI skills. VMI allows

the child to focus on the object and coordinate his or her limbs to perform the desired action. Another important gross motor skill that requires VMI is motor coordination, which is the process of obtaining visual information from the environment and then produces the correct motor response (Du Plessis *et al*., 2015:70). Moreover, if a child's eyes are not able to move quickly and accurately, he or she will not be able to compete in sport activities. FMS such as throwing, kicking and catching depend on VMI skills. Without proper VMI skills, children will struggle to accurately coordinate movements to produce the desired skill (Coetzee & Du Plessis, 2013:38).

MOVEMENT AND LEARNING

In the past, learning and motor development was regarded as two separate processes, activated in different areas in the brain. However, recent evidence suggests that they are more interrelated processes than originally thought (Davis *et al*., 2011; Lobo *et al*., 2013:95). Movement requires and provides the opportunity to transfer information between the two brain hemispheres. Therefore, in order to learn, children must move (Johnstone & Ramon, 2011:85).

Learning

Fugate *et al*. (2018:1) states that learning is dependent on physical movements of the body because information is obtained through both perception and action. Cognition is defined as "the acquisition, storage, transformation and use of knowledge" (Matlin, 2009:21), and involves a variety of mental activities such as "perception, action, memory, language, problem solving, reasoning, decision making and social interaction" (Lobo *et al.*, 2013:95).

Embodied cognition

Theories of embodied cognition suggest that cognition is highly dependent on the body and that information is received through both perception and action. It states that cognition is rooted in our bodies' interactions with the environment through sensory and motor experiences (McClelland *et al*., 2015:84; Fugate *et al*., 2018:1). Therefore, it could be assumed that the body itself is actively involved during learning and academic tasks, such as reading and writing. In order for cognitive processes to have an impact, they must be influenced by the body's actions and its motor and perceptual systems. According to the developmental systems view, the ability to execute a desired movement is dependent on the body-environment system (Adolph &

Franchak, 2017:1). The cognitive processes, in turn, assist our movements through decision-making, motor control and learning of a new motor skill (Geersten *et al*., 2016:2).

The brain

The link between movement and learning can be explained by the development of the brain (Khan & Hillman, 2014:139; Oberer *et al*., 2018:71). The ability to learn, memorise and perceive sensory information occur in numerous areas of the nervous system interacting in a complex way. Magnetic resonance imaging (MRI) studies have proven that the areas responsible for basic perceptual and motor processes are first to develop. The associative areas of the brain, responsible for language and higher-order skills, only develop after the perceptual and motor processes are well-established (Gligorovic *et al*., 2011:406).

Studies suggest that there is an underlying neural network that is responsible for both cognitive and motor processes (Davis *et al*., 2011:569). Brain regions responsible for learning, such as the hippocampus, are stimulated during physical activity (Oberer *et al*., 2018:71). The cerebellum, prefrontal cortex (Geertsen *et al*., 2016:3), basal ganglia and their connecting structures are all co-activated during both motor and cognitive tasks (Carlson *et al*., 2013:515; Oberer *et al*., 2018:3). This occurs especially if a task is complex, new, or when concentration is required to perform the task (Carlson *et al*., 2013:515).

Moreover, coordination and cognition are also interconnected because they occur in the same areas of the brain, specifically the cerebellum and frontal lobe (Lopes *et al*., 2013:10). The cerebral and prefrontal cortex is activated during conscious tasks involving attention, planning and decision-making. These are also the areas of the brain where specific motor task executions occur along with the cerebellum and basal ganglia (De Waal *et al*., 2018:967-968).

Movement

Although movement generally depends on the muscles and biomechanics to produce, control and manipulate physical forces, managing these forces requires more of a cognitive input. The ability to plan and effectively perform certain actions requires both perceptual and cognitive processing (Lopes *et al*., 2013:10). Physical activities requiring a high demand of coordination, demand higher-order cognitive processing

skills. When children learn new motor skills, it places a high demand on their cognition, thereby improving their higher order thinking (Oberer *et al*., 2018:71).

Moreover, learning activities, such as reading and writing, require both higher-level (e.g. cognitive components) and lower-level functions (e.g. sensory components). Higher-level functions have been found to be dependent on lower-level functions (Lopes *et al*., 2013:10). Movements generate sensory and perceptual information and provide the opportunity to acquire knowledge (Adolph & Franchak, 2017:1). Research has shown that cognitive and motor processes develop at the same rate, therefore, if a delay is caused in one area, the other will also be affected (Geertsen *et al*., 2016:2).

Movement has also been found to activate memory (Geertsen *et al*., 2016:2). Knowledge can be retrieved through the perceptual and sensory experiences. The same sensory experiences will be stimulated during thinking of an action, as well as when performing the action itself. This process is strengthened when a multi-sensory experience is created when learning an action or skill (Fugate *et al*., 2018:2). Furthermore, to be able to read and write, the brain utilises existing information obtained from sensory input, perceptual processing and motor control. Therefore, it is believed that the brain can only develop intellectual capacity once the child has learned to control his or her physical actions and sensorimotor maps have been stored in the brain (McClelland *et al*., 2015:84).

Gross motor skills

Gross motor skills involve movements using the body's larger muscles and includes skills such as balance, posture, locomotion and coordination (Gallahue & Donnelly. 2003:68; Flatters *et al.*, 2014:2907; Cameron *et al*., 2016:93). Most sport skills are classified as gross motor movements (Gallahue & Donnelly, 2003:68). Fine motor skills involve limited motion of the parts of the body, and usually include only movements of smaller muscles related to the control of the hand and fingers (Gligorovic *et al*., 2011:413) for activities requiring more precision (Gallahue & Donnelly, 2003:68).

The muscles responsible for gross motor movements have a big influence on the muscles required for fine motor movements (Gligorovic *et al*., 2011:413). Therefore, it is necessary for gross motor skills to be established before competent fine motor skills can be developed (Gligorovic *et al*., 2011:413). For example, the gross motor skills

involved during writing are responsible for postural control. By controlling the larger muscles in the neck, shoulder and trunk, it allows for stability for small muscle groups in the fingers and hands (Naider-Steinhart & Katz-Leurer, 2007:392). As children develop, control of muscles begins in their trunk, progressing to their elbows and then their hands. Proximal muscles should to be developed first, which are closer to the centre of the body, for the development of distal muscles (further from the centre of the body) to occur (Naider-Steinhart & Katz-Leurer, 2007:392). Furthermore, the process of learning to plan and execute gross motor skills develops motor planning and the ability to judge the proper force, timing and action to produce a specific outcome during a fine motor task (Naider-Steinhart & Katz-Leurer, 2007:393). A strong gross motor skills foundation has to be established before the development of fine motor skills, such as writing, can occur (Flatters *et al*., 2014:2908; Bara & Bonneton-Botte, 2018:124). Gross motor movements are also associated with numerous other academic skills such as interpreting letters and words (Nilukshika *et al*.,2012:208). Due to gross motor skills having such a large influence on academic performance, it is important that a child not only acquires these skills but should also be proficient in their execution. Motor skill competence can be defined in terms of being proficient in FMS (Stodden *et al*., 2008:293).

MOTOR PROFICIENCY

An important aspect of movement and motor development is motor proficiency. Children's movements in the fundamental movement phase start to become more refined and controlled. As they become more proficient in their movements, they are more able to engage in opportunities to learn and develop. Motor proficiency is defined as the ability to produce motor skills in a proficient manner by manipulating physical forces and cognitive processes to control movements (Bardid *et al*., 2013:1). Motor skills are referred to as the "underlying internal processes" (Cameron *et al*., 2016:93) that are responsible for moving the body and its limbs in space. They consist not only of the movements, but also of the cognitive processes causing those movements (Cameron *et al*., 2016:93). Motor proficiency also relies heavily on motor coordination, which refers to the ability of different muscles to cooperate to produce a purposeful movement (Bardid *et al*., 2013:1). It involves the development of complex movement sequences and motor control to produce both fine and gross motor movements (Pienaar *et al*., 2013:375).

Motor proficiency is also strongly related to academic performance (Pienaar *et al*., 2013:371; Ericsson & Karlsson, 2012:273; Da Silva Pacheco *et al*., 2016:967; Cadoret *et al*., 2018:150). The more proficient children become in their gross motor skills, the better their academic performance. This is because motor proficiency involves cognitive processes, such as motor planning, feedback and correction about a movement and monitoring postural control (Roebers & Kauer, 2009:175). Gross motor skills that have been found to influence cognitive tasks include: postural control; strength; balance; and coordination (El-Dayem *et al*., 2015:260). It is, therefore, important to determine how these skills are developed and how they influence children's cognitive skills.

Postural control and stability

Posture is important for all motor skills. One's posture must be sufficiently stable to allow coordinated movements of the extremities. The development of most motor skills can only occur after postural control is sufficiently developed (Flatters *et al.,* 2014:2908; Adolph & Franchak, 2017:2, 3).

In order to achieve good postural control, an individual must develop good core and upper-body strength. Previous studies have found strong correlations between strength and academic performance (Wittberg *et al*., 2009:33; Du Toit *et al*., 2011:31). Maintaining a stable posture allows an individual to perform daily tasks, such as sitting at a desk to read. Once a stable base of support is established, it allows for new opportunities to acquire knowledge and interact with the world (Adolph & Franchak, 2017:2,3). Stability in a sitting position provides more freedom for the arms and hands to reach and manipulate objects (Gligovoric *et al*., 2011:414).

Balance requires proficient postural control and has been proved to have a positive influence on reading in children aged 7 to 11 years old (Davis *et al*., 2011:570). Gligorovic *et al*. (2011:414), found that balance and the ability to copy shapes are strongly related. This implies that balance has an influence on the child's ability to copy shapes and letters. It can be assumed that this is because children with good balance and postural control have well-developed proprioception, and therefore, rely less on visual feedback (Gligovoric *et al*., 2011:414).

Furthermore, the perceptual and postural systems work closely together (Flatters *et al*., 2014:2908; Adolph & Franchak, 2017:4). A key role of the postural system is to

provide stability to obtain perceptual (visual) information from the environment, which, in turn, is vital to be able to guide coordinated movements of the hands and fingers (Flatters *et al*., 2014:2908). Perceptual information, on the other hand, is important to keep the body inside its base of support because it provides information of where the body is in space and where different body parts are in relation to one another (Adolph & Franchak, 2017:4). Moreover, good postural control and perceptual feedback are required for any goal-directed movement. It gives children more freedom to move their bodies without stabilising with their hands and visually guide their movements (Adolph & Franchak, 2017:8).

Coordination

Coordination involves the process of moving different body parts for a specific purpose. It requires movements to be fluid and without any associated movements. This enables the ability to develop new motor patterns based on previously learned motor patterns. Coordination also requires the integration of different senses, such as sight and proprioception with movements in order to produce smooth and coordinated motor skills (Pienaar, 2017:42).

Hand-eye coordination requires the vision system to integrate information obtained through the eyes. This is then used to control and direct the hands to accomplish a desired task (Kaiser *et al*., 2009:93). Numerous studies have concluded that poor hand-eye coordination is associated with poor handwriting (Tseng & Murray, 1994:32; Cornhill & Case-Smith, 1996:733; Kaiser *et al*., 2009:93). Moreover, motor coordination, specifically hand-eye coordination, in young children has been found to be a key predictor of academic performance in reading and mathematics (Rigoli *et al*., 2012:766).

Bilateral coordination can be divided into three types of movements, namely: symmetrical (when the upper and lower limbs perform the same movement at the same time); asymmetrical (when the upper and lower limbs move together but perform different movements); and alternating (when one limb alternates with the other). These three types of bilateral movements can be combined in different ways, for example, through bilateral combination (when both upper or lower limbs are used for an action); unilateral combination (involves the use of only one limb to perform a task); ipsilateral combination (when only one side of the body [upper and lower limbs] is used to

complete an action); and contralateral combination (the simultaneous movement of both sides of the body in contrast) (Pienaar, 2017:185).

Bilateral coordination helps develop motor control and coordination (Johnstone & Ramon, 2011:19). The coordination of movements involves a complex interaction between the perceptual, motor and cognitive systems (Gligorovic, 2011:422). Poor bilateral integration affects the child's learning and cognitive development. This is due to a lack of neural stimulation of the brain and poor coordination of the left and right sides of the brain and body (Johnstone & Ramon, 2011:19). Children with poor bilateral coordination also struggle to cross their midline, which leads to further problems in academic performance (Pienaar, 2017:189).

Furthermore, the coordination of the opposite sides of the body (contralateral coordination), involves information being transferred between the left and right brain hemispheres, which is connected via the corpus callosum. The corpus callosum is known to have a big influence on reading. Previous studies have found that repetitive contralateral movements cause maturation of the corpus callosum and, thereby, improves reading (McClelland *et al.***,** 2015:96).

Unilateral coordination helps to develop each hemisphere of the brain by isolating one side of the body. This strengthens each hemisphere individually and gets the brain ready to cross the midline. Isolating one side of the body develops neural pathways in the brain. These types of activities require the child to use one side of their body, and thereafter, use the other side of their body to strengthen both hemispheres (Johnstone & Ramon, 2011:19).

ACADEMIC PERFORMANCE

Despite the growing evidence of the benefits of movement and academic performance, schools of today are traditionally regarded as a place of formal learning, where children exhibit mostly sedentary behaviour (Norris *et al*., 2015:117). Inactive lifestyles among children often cause poor FMS and lower academic performance (O'Dwyer *et al.,* 2012:117). Movement is separated from education, while it should be an integrated part of learning, because children learn best through movement and active involvement (Samuelsson & Carlsson, 2008:623). Therefore, it is essential for the school curriculum to create more opportunities where children can move and develop their gross motor skills (Hardy *et al*., 2010:503).

South African school environment

The South African Department of Basic Education (DoBE) (2001:2) states that early childhood development is critical for the achievement of the different skills that establish the foundation for lifelong learning. Children acquire language, perceptual-motor, numeracy and problem-solving skills that are critical building blocks for their entire academic career. However, evidence suggests that children are not achieving these necessary skills. According to the South African Institute of Race Relations (SAIRR) (2018:3), the following percentage of children repeated Grade 1 between the years 2009 to 2015: 2009-6.9%; 2010-5.8%; 2011-6.9%, 2012-9%; 2013-10.7%; 2014-9.2% and 2015-7%. Statistics South Africa (SSA) (2016:6) released a report indicating that in 2015, 657 000 children attended Grade R, whereas over 1.2 million children attended Grade 1 in 2016. From these statistics, it is clear that there was a large number of children starting Grade 1 without having completed Grade R, and so did not acquire the necessary skills.

Physical Education curriculum

The Healthy Active Kids South Africa (HAKSA) Report Card (2018:4) stated that on average children in elementary school spend 70% of their school day sedentary. The recommended time for physical activity for school-aged children is three hours per day, which should include at least one hour of moderate to vigorous exercise (HAKSA, 2018:4). According to the Curriculum Assessment Policy Statement (CAPS), instructional time for Foundation Phase learners is approximately 23 hours per week. This consists of Language, Mathematics and Life skills. Of the 23 hours, only 2 hours are allocated for Physical Education (PE) where children can be active (DoBE, 2011:6).

However, although PE forms part of the South African school curriculum, its delivery is insufficient. A recent study reported that 32% of South African children do not participate in PE during school time (Silva *et al*., 2018:998). De Villiers *et al*. (2012:794) reported that although 59% of the Foundation Phase schools in the Western Cape had at least one PE session scheduled on their school timetable, only 22% of these schools implemented a PE session outside the classroom. There are several reasons for the insufficient implementation of PE in South African schools. A survey revealed that 19% of principals in the Western Cape stated that their schools do not have the appropriate

facilities to allow for increased PE and sport participation (De Villiers *et al*., 2012:794). Another possible explanation, as stated by Van Deventer (2009:140), is that there is simply a lack of time in the school curriculum. Other subjects are prioritized over PE because of the increasing demands on children's education. Teacher reluctance or inability and increasing teacher workloads are also reasons for the lack of adequate implementation of PE in South African schools (HAKSA, 2016:7). These are all contributing factors to children not achieving the recommended daily amount of physical activity.

Literacy curriculum

Before children start with formal handwriting teaching in Grade 1, they have to complete a pre-writing programme, which includes activities to develop visual discrimination, gross and fine motor skills, hand-eye coordination and body image. They are taught the correct pencil grip, formation of letters, spacing of writing and direction of writing. The curriculum allows 15 minutes per day for handwriting practice. By the end of Grade 1, children should be able to correctly form all upper- and lower-case letters and fluently copy sentences (DoBE, 2011:10).

A Grade 1 child should be able to perform the following reading skills (DoBE, 2011:20):

- Identify and form each letter and its sound.
- Build words using letters learnt.
- Group common words that have similar sounds.
- Develop book-handling skills (ability to turn pages and hold a book properly).
- Recognize their own name and names of peers.
- Develop directionality (understand concept of reading from left to right, top to bottom, front to back).
- Read with fluency and expression.
- Show understanding of punctuation when reading.
- Hold and manipulate a pencil or crayon in the correct way.
- Develop fine motor skills and hand-eye coordination.
- Trace and copy patterns and letters in correct direction.
- Copy sentences from a paper or board.
- Identify common double sounds (aa, ch, etc).

Although these are the necessary skills for Grade 1, evidence has shown that not all children meet the reading requirements but still progress through the Grades. The University of Pretoria conducted research which identified that eight out of 10 Grade 4 learners cannot read at the required level (Howie *et al.*, 2016:11). Therefore, there is a need to identify the underlying processes of reading and writing and implement methods for early intervention at the beginning of literacy development.

Reading, writing and spelling development

Children's literacy development begins with drawing. Handwriting begins with random scribbling, which eventually becomes more purposeful. When learning to write letters, children often start by copying the letters of their own name. They begin to write by copying the vertical strokes of the letter first, followed by the horizontal strokes and then the circular shapes (Diamond *et al*., 2008:468).

Children start learning letters at age five or six. Before the age of eight, their handwriting movements are still quite slow, with several pauses between each stroke. Children at this age still require permanent control and sensory feedback as they produce a letter. Sensory-maps of each letter have not yet been created and stored in long term memory (Kandel & Perret, 2015b:113). With practise, motor programs are created, which contains information of every letter as well as on the correct spelling of words. Once these programs are stored in long-term memory, the child will be able to activate these programs and produce letters and words quickly and effectively. There is less of a cognitive load when writing and the child relies less on the sensory feedback. These motor maps and programs are established around the age of 10 or 11 and motor production will then become more automatic (Kandel & Perret, 2015a:326; Kandel & Perret, 2015b:114).

Factors that contribute to learning different letters include letters in a child's name, textual frequency, number of strokes in the letter and letter symmetry (Puranik *et al*., 2014:154-156). Several studies have shown that children learn the letters contained in their name before any other letters (Puranik *et al*., 2011:7; Puranik *et al*., 2014:154). This is most likely because of the frequent exposure to their names at home and at school. Textual frequency is another contributing factor to letter recognition. The more the letter appears in words, the more likely the child is to identify it (Puranik *et al*., 2014:155). Furthermore, every letter differs in the number and combination of strokes

it contains. The stroke features have an influence on the amount and type of muscles in the wrist and fingers that are recruited. The less strokes the letter contains (for example, I) the easier it is for the child to recognize or form a letter. Lastly, children find symmetrical letters (for example, M/H), easier to form than asymmetrical letters (for example, J/R) (Puranik *et al*., 2014:155, 156).

Furthermore, the development of reading and writing rely heavily on motor skills as it forms a foundation for reading and writing (McClelland & Cameron, 2019:144). Sitting at a desk to read or write requires well-developed gross motor skills because it involves maintaining one's posture and using both arms and hands to perform different tasks simultaneously (holding book with one hand and writing with the other). Another important skill that is required for writing is motor anticipation. This skill allows for quick activation of information on what one must do next when forming a letter. It speeds up writing by producing fluent and fast movements (Kandel & Perret, 2015a:326).

Letter knowledge

An important feature for a child's literacy development is the acquisition of letter knowledge. Letter knowledge is a perceptual-motor task because there is an interaction between perception and motor output. Visual components of the letter are directly related to the motor components to form that letter (Bara & Bonneton-Botte, 2018:191). Therefore, learning to read, write and spell is enhanced by intensifying the motor experience and adding a sensory component (James & Engelhardt, 2012:2,3). Letter knowledge is comprised of two interacting skills known as letter recognition and letter formation. Letter recognition is further subdivided into letter naming and letter sound knowledge (Bara & Bonneton-Botté, 2018:191).

Letter recognition

One of the first steps in learning to read and write is grasping the skill of letter recognition (Kersey & James, 2013:1). Several studies show that early learning of letter recognition is a key predictor of later literary success (James & Engelhardt, 2012:3; Kersey & James, 2013:1). Letter recognition requires the child to process and apply visual information such as the size, location, orientation and angles of the letter (Finkbeiner & Coltheart, 2009:1, Kersey & James, 2013:1). It involves the ability to understand the difference between letters, numbers and other symbols or pictures (Puranik *et al*., 2011:3). To be able to read, the child has to quickly and accurately

name or identify a letter and then place them together to form a word (James & Engelhardt, 2012:1; Kersey & James, 2013:1). When spelling a word, the child also has to able to identify the different letters that make up that word (James & Engelhardt, 2012:1).

Letter naming requires the child to associate the shape of the letter with its name, whereas letter sound knowledge involves identifying the sound to the name and shape of the letter (Bara & Bonneton-Botté, 2018:191). To be able to recognize and form a letter, a child should also be able to identify the letter sound and name first (Puranik *et al*., 2011:11).

It is believed that letter recognition can be improved through printing (writing) letters because the child learns by perceiving the letter and creating a motor output to produce it. By printing a letter, significantly more neural pathways are activated (Kersey & James, 2013:1,2). Additionally, printing letters activates the motor cortex of the brain, which is also the part of the brain that is active during any perceptual-motor task (James & Engelhardt, 2012:12). When a motor movement is learned and a motor program is stored, the visual cortex is activated, which increases retrieval of information (Kersey & James, 2013:11). Furthermore, the insula and claustrum are involved during multisensory experiences and control the coordination and integration of sensory and motor components during writing (Kersey & James, 2013:13).

Letter formation

Handwriting, or letter formation, is a multifaceted skill, which requires a complex integration of cognitive, sensory and perceptual motor components, such as VMI, motor planning, motor proficiency, hand-eye coordination and proprioceptive feedback. Writing involves an integrated pattern of coordinated movements, which depends on visual perception, as well as sensorimotor feedback (Capellini *et al*., 2017:259). Letter formation requires that the perceptual aspects of letter recognition be integrated with the motor aspects of writing the letter (Puranik *et al*., 2011:12). It is, therefore, important to understand the processes underlying handwriting acquisition.

Previous studies have indicated that perceptual-motor deficits have a negative impact on handwriting. Both perceptual and motor components have to be stimulated to improve handwriting and reading. Creating a multisensory experience when writing or reading strengthens connections between the visual and auditory word information

(Van Reybroeck & Michiels, 2018:1320). Various studies have found that by making writing a sensorimotor experience, learning is enhanced because letters get stored in the child's long-term memory, thereby improving spelling as well (Zemlock *et al*., 2018:1257). By physically interacting with the environment, the sensory and motor systems are stimulated, thereby developing a clearer visual image and enhancing letter recognition (James, 2010:280).

According to Rosenblum (2015:203), a task such as writing consists of organization of different body movements. Movement production during letter formation requires peripheral processing (Kandel & Perret, 2015a:326). Motor programs are created comprising of information on the letter shapes, direction, orientation and stroke order (Kandel & Perret, 2015a:326). These movements require idea consolidation, motor planning and execution according to the spatial and temporal requirements (Rosenblum, 2015:203). The child focuses on forming the correct shape (letter) and connecting those letters to form a word (spell). Over time, this form sensory-motor maps, which are stored in long-term memory (Kandel & Perret, 2015b:114).

Common writing mistakes include incorrect letter formation, reversals, uneven size letters, irregular spacing between letters and slow production of a letter (Capellini *et al.*, 2017:259). A neuro-developmental disorder that can have an influence on children's reading and writing skills is known as dysgraphia, which is sub-dived into two categories: perceptual: and motor dysgraphia. Perceptual dysgraphia problems involve not being able to connect the visual representation of a letter with the sound it makes, whereas motor dysgraphia involves difficulties in the fine motor skills to produce the letter, such as when controlling finger movements when writing (Capellini *et al*., 2017:260).

Early intervention

Formal handwriting and reading instruction begin in Grade 1, therefore, it is important to start with interventions early in order to provide remediation to children who have handwriting and reading difficulties. Incorporating a multisensory remedial programme into the children's curriculum is important to prevent or improve any difficulties (Lust & Donica, 2011:561).

Early childhood is a critical phase of human development in which the child's environment and their experiences can either promote optimal growth or lifelong

limitations. Although these shortcomings might be treated later in life through special interventions, they are often very expensive and time consuming. Implementing an early intervention will be far more effective and prevent any serious implications (Sherry & Draper, 2013:1293).

Early movement experiences can form the foundation for the development of perceptual-motor skills and, as mentioned earlier, early childhood is the ideal period to promote these skills. Furthermore, early interventions will help prevent abnormal brain function and improve underlying mechanisms because neural plasticity is greatest during early childhood (Wuang *et al*., 2009:442). Finally, healthy physical activity habits are also more likely to be conserved if it is established earlier in life. If young children spend the majority their time sedentary, this behaviour will most likely stay with them in their adult lives, which can have detrimental effects on the health and overall well-being (Lu & Montague, 2016:409).

INTERVENTIONS

The most common intervention technique for reading and writing is a bottom-up approach, which focuses on the underlying components of handwriting such as sensory integration, visual perception and motor coordination. It focuses on remediating motor, sensory and perceptual skills. Another common approach is the top-down approach, which focuses primarily on cognitive strategies to improve legibility of handwriting. The best approach is to incorporate these two strategies, focusing on both the underlying components, as well as the cognitive elements (Cramm & Egan, 2015:170).

Multi-sensory approach

Numerous studies have shown that multi-sensory methods are very beneficial for the remediation of reading and writing difficulties (Bara *et al*., 2007:644; Lust & Donica, 2011:561). By adding another sensory component to any task, learning is enhanced. Bara *et al*. (2007:644) concluded that reading and writing interventions should include not only visual components, but incorporate the stimulation of the proprioceptive, tactile, auditory and movement systems, as all these components have an influence on children's academic performance. By stimulating sensory and motor skills, improvement can be observed in both perceptual and academic performance (Wuang *et al*., 2009:442). According to Ayres' theory on sensory integration, sensory

information is not processed in isolation; therefore, interventions that incorporate the child's senses to apply a multisensory approach will have a positive influence on their learning and behaviour (Ayres & Robbins, 2005:11).

Previous studies

Numerous previous studies have investigated the effect of multi-sensory approaches to improve motor and cognitive skills. In the following sections the aims and results of the different studies will be discussed, as well as how it will be applied in the current study. A summary of all previous summaries mentioned in the literature below is presented in Table 2.1 on p. 42.

Reading and writing interventions

Several studies have compared the effect of a sensorimotor approach on handwriting with a more task-orientated intervention (Denton *et al.*, 2006:20; Weintraub *et al.*, 2009:131). In a study done by Weintraub et al. (2009:131), a group of children in Grades 2 to 4 (N=55) were randomly assigned to a sensorimotor intervention (n=19), a task-orientated intervention (n=19) and a control group who received no intervention (n=17), after which handwriting was examined. Assessments were done immediately after intervention and again four months after the intervention. The study followed a single blinded experimental design. Immediately after the intervention, both intervention groups improved in overall legibility. The study showed that by incorporating multisensory tasks, such as kinaesthetic, tactile and auditory feedback with learning letters, significantly improved letter formation. However, a significant difference in the overall legibility was only seen in the task-orientated group. Four months after the intervention, the study showed that the task-orientated group scored significantly higher than the sensorimotor group in overall handwriting legibility. It could be argued that the small sample size does not allow for generalizability of the results. Furthermore, the activities only involved fine motor tasks using mainly their hands and fingers and did not investigate the effect that gross motor movements might have had on handwriting skills (Weintraub *et al.*, 2009:131). Denton *et al.* (2006:20), compared a sensorimotor intervention with a therapeutic practice intervention to improve children's handwriting. The therapeutic intervention involved practicing and copying letters and words on a work sheet whereas the sensorimotor intervention focused on visual perception, VMI, proprioception, and in-hand manipulation skills through fine

motor tasks. Both interventions were conducted in small groups, four times a week for 5 consecutive weeks with a total intervention time of 10 hours over the 5 weeks. The control group received no intervention and participated in their normal classroom activities. Although some sensorimotor components improved with the sensorimotor intervention, the study found no significant results on handwriting performance. This intervention primarily focused on the underlying components of handwriting but did not incorporate any letters into the activities itself. The study concluded that a therapeutic intervention was more effective in improving the participants' handwriting. However, the control group (n=9) was much smaller than the intervention groups (sensorimotor group: n=14 and therapeutic intervention group: n=15. Furthermore, the total intervention time was only 10 hours and therefore did not allow sufficient time to obtain significant results (Denton *et al*., 2006:23). Although both these studies found that task-orientated methods are more effective than a sensorimotor interventions on children's handwriting, both studies only included fine motor activities within their sensorimotor intervention and did not investigate the effect of a gross motor intervention on participants' writing skills.

Studies incorporating physical activity with learning yielded significant results (McClelland *et al.*, 2015:94; Mullender-Wijnsma *et al*., 2016:2; Bara & Bonneton-Botte, 2018:200). Incorporating physical exercise into academic lessons is efficient because of several reasons: firstly, during this type of intervention, sensorimotor information is obtained, which is an effective tool for learning; and secondly, there is increased brain activity that occurs during exercise, which improves attention (Mullender-Wijnsma *et al*., 2016:2). A 22-week physically active academic intervention was performed on elementary school children to determine the effect on their overall academic performance. Participants from 12 schools were randomly assigned to experimental (n=249) and control groups (n=250). The experimental group participated in the intervention, three times a week for 20 to 30 minutes. Participants were assessed using two language tests for reading and spelling, specifically the One-minute reading test and the Child Academic Monitoring System. The Speed Test-Arithmetic assessments was used to measure the participants' math speed. The study yielded significant results for maths and spelling; however, no improvement was seen in the participants' reading scores (Mullender-Wijnsma *et al*., 2016:7). Bara & Bonneton-Botte (2018:193) performed a study to investigate the effect of a whole-body gross

motor intervention on teaching letters. The following variables were assessed: letter recognition, letter knowledge, letter handwriting under dictation and letter copying. In the intervention learners were required to produce and explore letters with their arms or body without the use of a pencil through gross motor movements. They found a significant improvement in the learners' letter recognition. The study concluded that their main finding was that gross motor exploration of the letters had a positive impact on the participants' letter recognition. One possible reason for this might be explained by the embodied cognition theory, which highlights that there is a strong correlation between the visual and motor system. Therefore, using motor gestures reinforces the visual recognition of the letters. The study also concluded that letter recognition is enhanced more by larger whole-body movements than by typical handwriting movements using only their hands (Bara & Bonneton-Botte, 2018:200). However, this study did not explore the transfer of these key skills (letter recognition, letter knowledge, letter handwriting and letter copying) to other academic skills such as reading and spelling. This highlights the question whether a whole-body gross-motor intervention will be an effective tool in improving children's reading and spelling abilities.

A study done by McClelland *et al*. (2015:84), explored the effect a physically active programme will have on the reading and math skills of children aged 7 to 13 years. The intervention was based on the embodied cognition theory, which states that cognitive skills are dependent on knowledge that comes from the body. Activities included aerobic exercise, bilateral coordination, limb movement patterns, visual tracking and also incorporated body awareness and proprioceptive stimulation. The study concluded that this approach yielded statistically significant results in improving the reading and math scores of the participants. The improvement may be partly due to the bilateral and cross-lateral coordination activities included in the intervention. These types of movements require information to be transferred from the one side of the brain to the other via the corpus callosum, which is an essential structure for reading (McClelland *et al*., 2015:94-96). The study revealed that when a child has well-developed unilateral, bilateral and cross-lateral coordination, it aids the child during reading because he/she can now move from the left side of the page to the right side (Johnstone & Ramon, 2011:19). Therefore, based on these above-mentioned studies, it could be assumed that a gross motor or physically active intervention could be

beneficial for children's letter recognition abilities as well as their reading and spelling scores.

Perceptual-motor interventions

What makes perceptual-motor interventions effective and unique is that this method has proved to improve children's academic, as well as their motor skills (Pienaar *et al*., 2011:126; Hajezi *et al*., 2013:5; Sajedi & Berati, 2014:14; Erasmus *et al*., 2015:3).

Perceptual-motor interventions with the aim of improving motor skills have produced significant results, proving that perceptual-motor skills are essential for overall motor development (Hajezi *et al*., 2013:5; Sajedi & Berati, 2014:14). One study performed an 8-week perceptual-motor training programme on 4 to 6-year-old children. The study followed a quasi-experimental research design with an experimental (n=30) and control group (n=30). The Bruininks-Oseretsky Test of Motor Proficiency was used to assess the participants' motor proficiency skills. The perceptual-motor training programme occurred once per day for 8 weeks and included focuses such as body awareness, eye-hand coordination, spatial awareness and visual perception. The study showed significant improvements in the experimental group's overall motor proficiency, with significantly higher scores than the control group (Sajedi & Berati, 2014:16). Hajezi *et al*. (2013:2) explored the effect that a 10-week perceptual-motor intervention would have on Grade 1 children's (N=120) hand-eye coordination. Participants were randomly selected and divided into a control (n=60) and experimental group (n=60). The quasi-experimental study concluded that the intervention had a positive meaningful effect on the participants' hand-eye coordination scores (Hajezi *et al*., 2013:5).

Other perceptual-motor interventions focused primarily on improving children's cognitive skills (Pienaar *et al*., 2011:126; Erasmus *et al*., 2015:3). A quasi-experimental study was done on Grade R learners' school readiness to determine the effect of a 10-week perceptual-motor intervention on the participants' school readiness. Grade R learners were purposively sampled from two different quintile schools and assigned to an experimental (quintile 1, n=21) and control group (quintile 2, n=27). The study used a mixed method design, collecting both quantitative and qualitative data using the Le Roux's Group Test for School Readiness as well as teacher interviews. The 10-week intervention consisted of 40-minute sessions 3 times

a week. Significant improvement in the experimental group's visual perception and language scores, as well as their overall school readiness was found, adding to the evidence that perceptual-motor interventions are beneficial for improving cognitive skills. However, there are several limitations to this study. Firstly, one school was conveniently selected as the experimental group and the other as the control. Participants from each school were not equally assigned to a group. This limits the ability to generalise the results. Furthermore, as one school was assigned to an experimental and the other to a control group, it could be argued that the different teachers and environments could have had an effect on the final results (Erasmus *et al*., 2015:3). Another study by Pienaar *et al.* (2011:126) investigated the effect of a 7-month Kinderkinetics perceptual-motor programme on the cognitive functioning, as well as the perceptual-motor skills of pre-school children. The two-group pre- and post-test design conveniently selected 32 children from the University's Clinic for Kinderkinetics centre and assigned to an experimental (n=13) and control group (n=19). The Peabody Developmental Motor Scales 2 (PDMS-2), the Junior South African Individual Scale (JSAIS) and was used to measure the participants' motor and cognitive skills. The study's main finding was that the intervention was effective in improving the participants' perceptual-motor, as well as some of their cognitive concepts, attention and observation skills. The study, however, also have numerous shortcomings. The sample group was selected due to availability and not by means of random selection and was also small. This limits the ability to generalise the results. Furthermore, the sample included a broad age range (4 to 6-year olds) of participants. This may have influenced results as there is a possibility of age and maturation differences at this age range (Pienaar *et al*., 2011:126).

Motor proficiency interventions

Various different studies have also investigated interventions to improve motor proficiency and FMS. Au *et al*., (2014:993) performed a study to compare the effectiveness of a core stability programme with a task-oriented motor training programme on children's motor proficiency. The study was performed on children diagnosed with Developmental Coordination Disorder (DCD) (N=22) between the ages of 6 to 7 years. After being randomly assigned to each of the intervention programmes, participants were evaluated with the BOT-2 Short Form as well as a Sensory Organization Test. The core stability intervention had a more bottom-up

approach, which focused on strengthening the participants' back, core and postural muscles. The task-oriented programme, which is more of a top-down approach, focused on training more functional tasks, such as running, galloping, hopping and jumping, while changing the surface, speed, direction or pattern of movement. After the 8-week intervention, results revealed a significant improvement in both groups' overall motor proficiency scores, however there were no significant between-group differences. Although this shows that both bottom-up and top-down approaches can be beneficial for children's motor development, the study had a very small sample size and no control group. Therefore, it could not be concluded that the improvement in the participants' motor proficiency scores are merely due to the intervention and not because of other common variables that may have affected the groups (Au *et al*., 2014:1001).

Another study performed by Donath *et al*., (2015:1179) investigated the effect of an intervention on the object control proficiency of pre-school children (N=41). Participants were randomly assigned to an intervention (n=22) and control group (n=19) group and were evaluated using the Test for Gross Motor Development, Second Edition (TGMD-2). The intervention consisted of twelve 30-minute sessions for 6 weeks and focused on different object control skills. Results revealed a significant improvement as well as a significant between-group difference in the stationary dribble subtest. However no between group differences or significant improvements were seen in the catching, kicking, rolling or throwing subtests. As this intervention approach was more task-oriented it could be assumed that not enough focus was placed on the underlying skills required for improved object control proficiency (Donath *et al*., 2015:1185).

Burns *et al.,* (2017:1121) examined the effects of a 12-week physical activity programme on gross motor skill development in 8 to 9-year-old children (N=1460). The intervention included PE sessions, activity sessions during recess time as well as classroom brain breaks during class time. Participants' gross motor skills were measured using the TGMD-2 at baseline, 1 week prior to the intervention and again after the intervention. After ANOVA analysis was done, a statistically significant improvement was seen in the overall gross motor skills of the participants. Although the study did not have a control group, the study provides further support for the

implementation of structured PE during school time as it has a positive influence on children's overall motor development.

This wide range of effective interventions mentioned above, involving perceptual-motor, gross-motor, as well as sensorimotor components suggests that working with the body to learn are valuable tools to improve children's physical and cognitive development. Furthermore, it could be assumed that by incorporating the bottom-up approach (underlying components) with the top-down approach (cognitive strategies) is the best approach for children's handwriting performance (Cramm & Egan, 2015:170).

Current study

The current study applied a perceptual-motor intervention, using a Kinderkinetics approach and thereby integrated sensorimotor components by using full body movements to provide different sensory stimulations. A bottom-up approach combined with a top-down approach was applied by integrating letters into gross motor activities and, thereby, creating a multi-sensory experience. No research was found that exactly replicated the current study's use of a perceptual-motor intervention to improve Grade 1 children's letter knowledge and motor proficiency skills.

SUMMARY

This theoretical context chapter reflected on and integrated past research findings related to the current study. The development of Grade 1 children was discussed along with factors that have an influence on their development. This was followed by an in-depth explanation of perceptual-motor development and how this relates to their overall physical and cognitive development. Specific perceptual-motor skills were also explained along with their relevance in the current study. The relationship between movement and learning was discussed, explaining how one is dependent on the other. Motor proficiency was also discussed, as well as the importance to become proficient in specific skills for academic performance. The South African school environment and curriculum was presented and an explanation of reading and writing development was given. Lastly, previous intervention techniques and approaches were examined.

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CHAPTER 3

METHODOLOGY

Referencing within the chapter and the list of references at the end thereof has been done in accordance with the guidelines of the Department of Sport Science, Stellenbosch University.

INTRODUCTION

Research requires systematic methods to obtain, analyse and interpret data. Researchers must adhere to these methods in order to maintain integrity in an academic field. The methods involved in scientific research include: stating the problem; formulating a hypothesis; collecting and analysing data; and forming a conclusion based on the results obtained (Thomas *et al*.,2011:12-14).

The researcher has to control all external factors to be able to prove a causal relationship and deduce that the change in the dependent variable (in the case of the current study: letter-recognition and -formation and motor proficiency), occurred because of the independent variable (in the case of the current study: perceptual-motor intervention) (Thomas *et al*., 2011:12-14).

In this chapter, the current study's methodology is outlined and a detailed explanation of the research methods that was followed, are discussed. The research problem and specific aims are defined, as well as a description of the participants included in the study. Methods of data analysis are explained, and the ethical process followed is outlined. The assessment instruments used to measure motor proficiency, reading and spelling, as well as visual motor integration are presented. Furthermore, the final section of this chapter discusses the intervention and the different theories and approaches used to design the intervention.

RESEARCH METHODOLOGY

There are various types of research methods that give researchers a variety of choices when conducting a study. Experimental research methods are used when the researcher wants to establish cause-and-effect relationships by controlling and manipulating treatments (Thomas *et al*., 2011:21). In this case, the researcher needs to attempt to control all possible factors that might have an influence on the study.

A quasi-experimental research design was applied in the current study as the selected schools were not randomly selected. Schools were selected based on logistical reasons, such as their proximity and availability. Quasi-experimental research designs are used when randomisation is not possible because of logistical or practical factors (Thompson & Panacek, 2006:245). Although quasi-experimental designs are not as scientifically valid as true experimental research designs, they are considered to be a better option for some research questions. They are used to validate treatment

methods or establish potential relationships between variables. This design is often used as a stepping-stone to test a hypothesis and establish a rationale for future true-experimental research studies. There are two types of quasi-experimental research designs namely: the group sequential design; and cohort studies (Thompson & Panacek, 2006:245). The current study implemented the cohort study design, which is when a study group of common characteristics are chosen and divided into an experimental and control group. This study design was used to test cause and effect relationships between variables (Thompson & Panacek, 2006:245). Quantitative data was collected through evaluations administered before and after an intervention. The effects of the intervention were measured by dividing the subjects randomly into a control group, who did not take part in the intervention, and an experimental group who did participate in the intervention.

The study was triple-blinded because the intervention was unknown to: (a) the research participants; (b) the individuals who administered the intervention and assessment; and (c) the individuals who interpreted the results. The purpose of a triple-blinded study is to reduce assessment bias and to increase the validity and accuracy of clinical outcomes (Salkind, 2010:1541). The following steps were taken to ensure the triple-blind study method was accurately implemented: subjects did not know prior to testing if they were in experimental or control group; the assessors were unaware of which children were in experimental and control groups and the intervention presenters had no interaction with any of the participants prior to the start of the intervention. Each participant was randomly assigned a number from 1-100. The individual who scored the tests and analysed the results was not aware which numbers were in the control or experimental groups. The same procedures were followed for pre- and post-tests.

AIMS AND OBJECTIVES

Primary Aim

To investigate the effect of a perceptual-motor intervention on the motor proficiency, letter recognition and -formation of selected Grade 1 children.

The specific aims and objectives of each article (Chapter Four and Five) are as follows:

Research article one (Chapter Four):

Research question 1: What is the effect of a perceptual-motor intervention on the letter knowledge (Letter recognition and -formation) of selected Grade 1 children?

Sub aim 1: To determine the effect of a perceptual-motor intervention on the letter knowledge (letter recognition and –formation) of selected Grade 1 children.

Objectives:

1. To evaluate the participants' VMI and reading and spelling skills by using the Beery-Buktenica Developmental Test of Visual-Motor Integration (Beery VMI) and the ESSI Reading and Spelling tests.
2. To examine the effectiveness of a perceptual-motor intervention by comparing results of the pre- and post-tests of the Beery VMI and ESSI Reading and Spelling tests.

Research article two (Chapter Five):

Research question 2: What is the relationship between motor proficiency and letter knowledge of selected Grade 1 children after participation in a perceptual-motor intervention?

Sub aim 2: To determine the relationship between motor proficiency and letter knowledge of selected Grade 1 children after participation in a perceptual-motor intervention.

Objectives:

1. To evaluate the participants' fine- and gross-motor proficiency using the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2).
2. To examine the effectiveness of a perceptual-motor intervention by comparing results of the pre- and post-tests of the BOT-2.
3. To examine the results of the BOT-2 in relation with the results of the ESSI Reading and Spelling tests.

RESEARCH DESIGN

A study design is important in research. It is a method of planning how the research questions will be answered and how the hypothesis will be tested. It minimises bias and improves the quality of research (Thomas *et al*., 2011:21).

Sample

There are two categories of sampling known as probability and non-probability sampling. Probability sampling is the process whereby the sample is randomly selected and every unit in a specific population has an equal chance of being selected for the sample. During non-probability sampling, the sample is not randomly selected, but is chosen based on the subjective judgement of the researcher (Joubert *et al*., 2016:95, 96). The choice of sampling technique depends on the purpose of the research. In the current study, non-probability sampling was used by means of a convenient sample (Figure 3.1).

The participating schools in this study were selected because of their proximity and availability. The two participating schools were readily accessible to the researcher and were selected from the Stellenbosch (School A) and Bellville (School B) areas. Their proximity made it financially and logistically more convenient for the researcher as no extra transport or assistance was needed. School A is a full-service public school for Afrikaans and English-speaking learners. The school is categorised as a Section 21 school[1] and is classified under quintile 2[2]. In 2018 (year intervention was conducted), there were 100 Grade 1 learners with 2 Afrikaans and 2 English classes. The student teacher ratio is 26:1. School B is also a full-service public school for Afrikaans and English-speaking learners and categorised as a Section 21 school and classified as a quintile 5 school. In 2018 there were 124 Grade 1 learners with 3 Afrikaans classes and one English class. The student teacher ratio of school B is 24:1.

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[1] The South African Schools Act (DoE, 1996:10) identifies two kinds of schools, namely Section 20 and Section 21. Section 21 schools are allocated finances by the department and are responsible for their own management and acquisition of stationary, textbooks, bills and maintenance.

[2] South African public schools are categorised into different quintiles based on the socioeconomic status of the school as well as the average income, unemployment rates and literacy level in the geographical area. Schools in more economically disadvantaged areas are categorised as Quintile 1 and those in more economically advantaged areas are categorised as Quintile 5. Schools in Quintiles 1 to 3 are non-fee-paying schools and receive more funding per learner from the government than schools in Quintiles 4 and 5 (Ogbonnaya & Awuah, 2019).

Both schools follow the South African curriculum, namely the Curriculum and Assessment Policy Statement (CAPS).

The sample groups in each school were selected according to homogenous purposive sampling because the main aim of the study was to determine the effect the perceptual-motor intervention had on Grade 1 children (Figure 3.1). Homogenous purposive sampling is used when the goal is to focus on specific characteristics of a population group. Grade 1 children were chosen because it is the age where children are required to master letter recognition and formation.

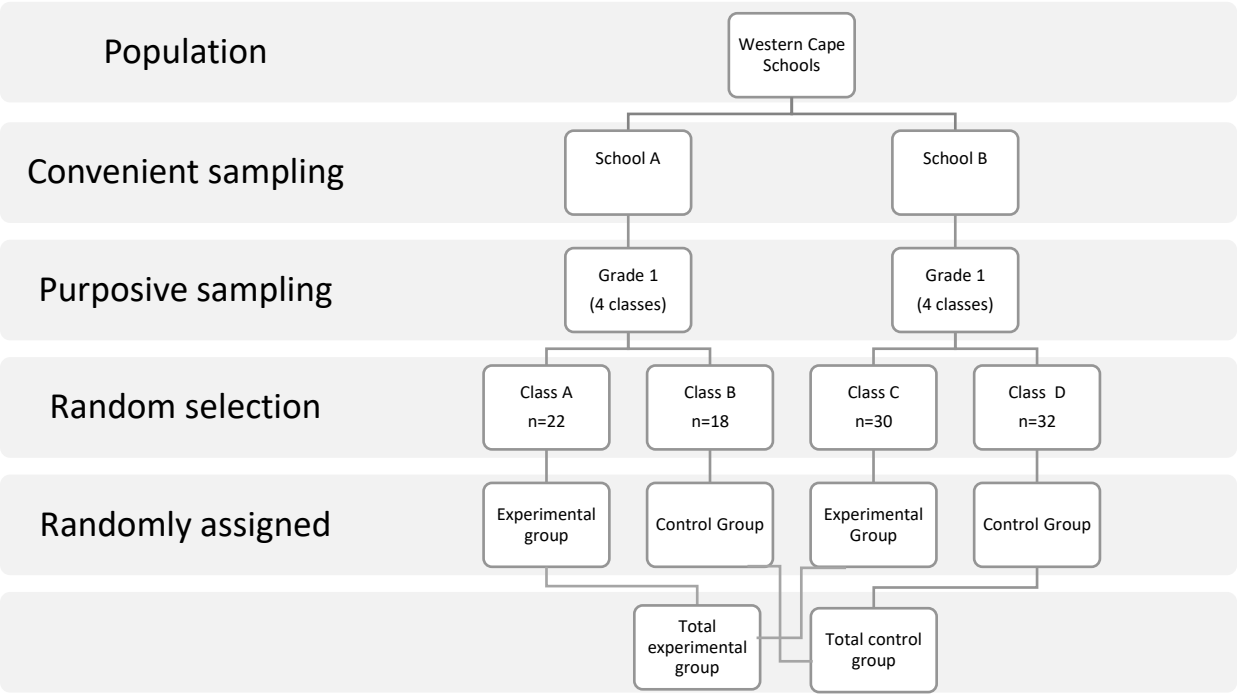

FIGURE 3.1: **SAMPLING METHOD**

In each school, four Grade 1 classes were available (School A=100 and School B=124). Two Grade 1 classes from each school were randomly selected by the school administrators to participate in the study. All 4 of these classes from both schools were Afrikaans-speaking learners. Classes were then randomly assigned to the control and experimental groups. One class from each school formed the control group and the other class the experimental group (Figure 3.1). The experimental groups took part in the perceptual-motor intervention, whereas the control groups continued with their normal school day. The control groups would take part in the programme after completion of the study. School A had 62 participants (N=62), with 30 learners (n=30) in the experimental group and 32 participants (n=32) in the control group. School B

consisted of 38 participants (N=38), with 20 participants (n=20) in the experimental group and 18 participants (n=18) in the control group (Table 3.1).

TABLE 3.1: **PRE-TEST SAMPLE SIZE**

Pre-Test			
Schools	**Experimental group**	**Control group**	**Total**
A	30	32	62
B	20	18	38
Total	50	50	100

After the post-test, 2 participants were excluded from the experimental group because of health reasons and 1 participant was excluded from the control group because of non-attendance. Therefore, the final sample size was 97 Grade 1 learners (N=97) (Table 3.2).

TABLE 3.2: **POST-TEST SAMPLE SIZE**

Post- Test			
School	**Experimental group**	**Control group**	**Total**
A	28	32	60
B	20	17	37
Total	48	49	97

Participants were included or excluded based on certain inclusion and exclusion criteria.

According to the inclusion criteria participants had to:

- attend the schools selected for the study;
- be in Grade 1, aged 6 to 7 years; and
- be able to attend 70% of the sessions.

Both boys and girls were included in the study.

According to the exclusion criteria participants were not included if they*:*

- did not complete their assent forms and/or did not bring back completed consent forms;
- were unable to attend either the pre- or post-test sessions; and
- refused to or was unable to participate in the perceptual-motor intervention.

Setting

The assessments, as well as the perceptual-motor intervention, took place at the selected schools. Assessments were done in a quiet hall or room, free from distractions and the intervention took place outside on a field or courtyard. The size of the assessment and perceptual-motor intervention rooms and fields can be found in Appendix H.

Data analysis and interpretation

The data was analysed by Professor Martin Kidd, Director of the Statistical Consultation Centre at Stellenbosch University, using the Statistica®, version 13.5.0.17. Repeated measures ANOVA was applied to examine the effects of the perceptual-motor intervention on the outcome measurements. In this model, the participants were included as random effect and group (experimental or control), and time (pre- or 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 95% ($p<0.05$) confidence interval was used as guideline for significant results. Pearson correlations were used to investigate possible relationships of the ESSI Reading and Spelling variables with the BOT-2 variables. Correlation (r) is a statistical method used to measure a possible linear relationship between two variables (Mukaka, 2012:69). When $r>0$, it indicates a positive association and when $r<0$, it indicates a negative relationship. The strength of the relationship between two variables increases as r moves closer to 1. The following demonstrates the strength of the relationship for each absolute value of r (Mukaka, 2012:69; Moore *et al*., 2013:71):

- $r<0.3$ - none, or a very weak correlation;
- $0.3<r<0.5$ - weak correlation;
- $0.5<r<0.7$ - moderate correlation; and
- $r>0.7$ - strong correlation.

Correlation coefficients have a p-value, which indicates the probability that the relationship between the two variables is equal to zero. Strong correlations have lower p-values because the probability that there is no relationship is very low. Correlations with a p-value less than 0.05 ($p<0.05$) are considered statistically significant. The following must be reported to describe a relationship between two variables: the strength of the correlation (r-value); the direction of the relationship (positive or negative); the shape of the relationship (linear); and whether the relationship is statistically significant ($p<0.05$). The Pearson correlation always describes a linear relationship (Moore *et al*., 2013:71). After data analysis was done, further data analysis was conducted whereby the schools were added as a factor. This revealed that the schools had no influence on the results, and, therefore, it was not reported.

Ethical aspects

Ethical clearance was obtained from the Research Ethical Committee of Stellenbosch University (REC-2018-7126) (Appendix M). The Western Cape Education Department (WCED) also approved the study (Appendix L). Only after permission was gained from both the WCED and REC of Stellenbosch University the study commenced.

Fouka & Mantzorou (2011:3-7), highlights the main ethical issues when conducting research according to the following ethical aspects: a) informed consent and autonomy, b) beneficence and non-maleficence, c) and respect for anonymity and confidentiality.

Informed consent is one of the ways by which participants' right to autonomy is protected. It needs to include an explanation and the purpose of the study and the procedures that will be followed. The researcher also has to describe any physical implications or dangers and procedures that will be put in place to prevent or minimize these dangers. Methods with which the participant's anonymity and confidentiality would be protected need to be described as well as the fact that the participant can withdraw from the study at any time (Fouka & Mantzorou, 2011:3). For the current study, permission was attained from each school, school principal and the teachers of the selected classes. Consent was obtained from the parents using a consent form explaining the details of the study as stated above. The consent forms were available in both English (Appendix C) and Afrikaans (Appendix D). The parents were given ample time to contact the researcher should they have any questions regarding the

research. Permission from the participants was obtained by means of an assent form. However, the study was also verbally explained to the participants to avoid any confusion. Assent forms were also available in English (Appendix E) and Afrikaans (Appendix F). Participants were allowed to withdraw from the study at any time if they wished to no longer participate.

The researcher upheld the ethical principles of beneficence (moral obligation to do good to others) and non-maleficence (moral obligation to do no harm) by minimising the risk of harm to the participants (Fouka & Mantzorou, 2011:9). Children were under constant supervision by more than one supervisor throughout the entire duration of the perceptual-motor intervention. All the intervention administrators and supervisors were trained and qualified in paediatric first aid. No invasive techniques were used in the assessments or during the intervention. Assessments were done in a manner that made children feel comfortable and all activities in the programme were safe and presented no danger to the participants. Ample water breaks were given in between activities and in the event of rain or extreme heat, activities were moved to an indoor facility. Furthermore, the potential benefits of participation far outweighed the possible risks.

Numerous steps to respect and protect the confidentiality and privacy of the participants' information and data were taken. All data was treated as confidential and stored on the researcher and study leader's computers and external hard drives, which were stored securely in a locked office at the Department of Sport Science at Stellenbosch University. Laptops were password-protected and the folder in which the information was saved had a secure password. Hard copies were safely stored in a safe at the Department of Sport Science. Data was only accessed by the main researcher, study leader and statistician. No personal information will be shared to any other person or the public.

PROCEDURES

Standardised tests and assessments were used to collect data from the participants. Primary data was collected directly from the participants. The first two weeks of the study consisted of a pre-test, followed by a 12-week intervention and two weeks of post-tests. A detailed timeline of the study is provided in Figure 3.2.

Measuring instruments

All assessments were done by qualified Kinderkineticists and Kinderkinetics Honours students who were trained by the main researcher. All the assessors were qualified in administering each of the three tests. Each assessor pre- and post-tested the same participant. During group tests, the same assessor administered the pre- and post-tests to ensure reliability and consistency within the test protocol. During assessments, all tests were supervised by the main researcher to ensure validity. All tests were scored and analysed by the main researcher.

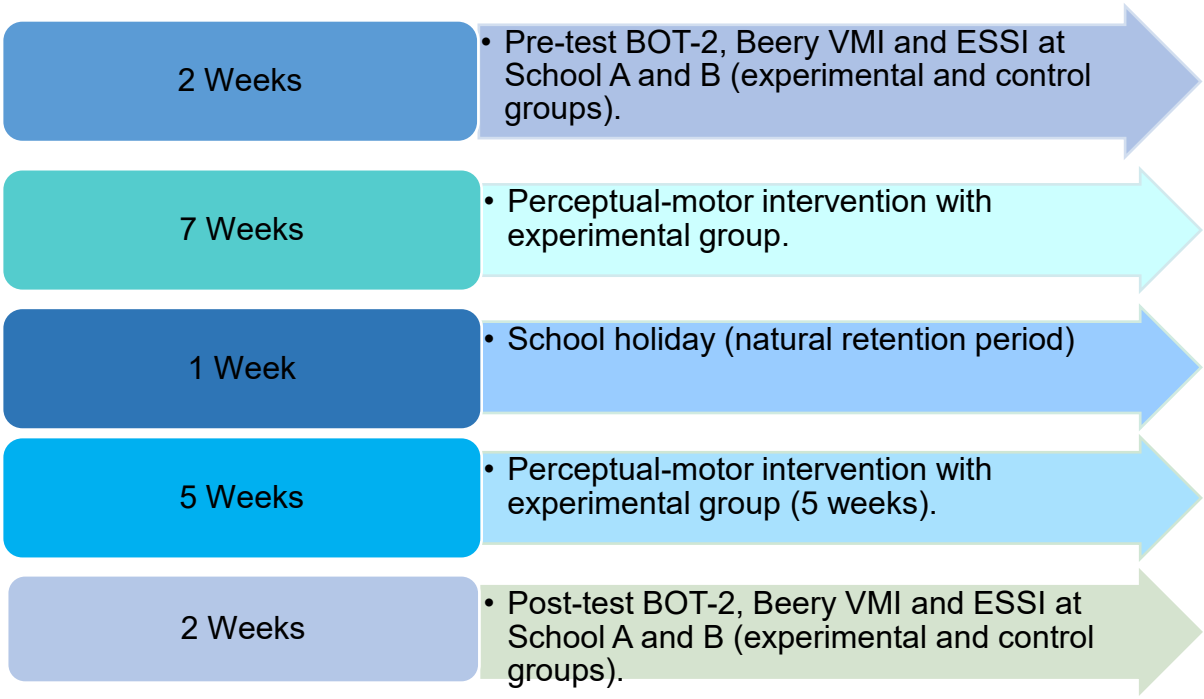

FIGURE 3.2: **STUDY TIMELINE**

Process- vs Product- oriented motor tests

In order to assess motor proficiency, one has to explain and understand the difference between process and product movement patterns and how each develops. Process-oriented assessments aim to evaluate how the specific movement is performed and describes qualitative movement patterns. Examples of these types of tests include the TGMD-2, Get Skilled test and developmental sequences. Product-oriented assessments, in turn, evaluates the outcome of a movement, and provides a quantitative score. Examples of this includes any test that evaluates the speed or distance an action is performed or the number of successful attempts of a certain skill (Logan *et al*., 2017:634; True *et al.,* 2017:321). Process-oriented assessments provide detail on how a skill is performed, and thereby, provides information on which part of

the skill still needs improvement. Product-oriented assessments, on the other hand, provides more concrete information to determine of the skill was done correctly (True *et al.,* 2017:330). It is suggested that a combined use of product-oriented and process-oriented measures can provide a more comprehensive assessment of motor competence.

Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2)

The BOT-2 is a widely used standardised test for motor proficiency and is considered the gold standard for motor assessment (Davis *et al*., 2011:572). It provides a detailed assessment of both gross and fine motor proficiency and measures a wide range of motor skills in individuals between the age of 4 to 21 (Bruininks & Bruininks, 2005:2). The BOT-2 is a widely used test that has been administered with the South African population (Peens *et al*., 2008:316; Du Toit *et al*., 2011:25; Pienaar & Kemp, 2014:167; Pienaar *et al*., 2013:370).

There are two forms of the BOT-2, namely the complete or the short form. The complete form provides the most reliable measure of the participants' overall motor proficiency, however, the admistering time is relatively long, ranging between 40 to 60 minutes. The short form is an effective screening tool as it is a fast and easy to administer assessment and provides the researcher with a single score of the participant's overall motor proficiency. It is used as a screening tool to determine whether a further, more in-depth assessment is necessary using the BOT-2 complete form. The admistering time varies between 15 to 20 minutes, with a approximate 5-minute setup time (Bruininks & Bruininks, 2005:2). The BOT-2 short form was used in the current study to obtain a single score of overall motor proficiency. Venetsanou *et al*. (2009:544) evaluated the use of the BOT-2 Short form for screening in preschool children and concluded that the short form is a valid screening method for children older than 6 years old. However, the study also indicated that due to the floor effect, the BOT-2 Short Form is not suitable for children younger than 6 years old. As all participants in the current study was older than 6 years old, this will not have an effect on the final results. Another study aimed to determine whether the BOT-2 Short Form are strongly associated with the total point score. The study concluded that all items, except for Strength, have very low yield items. This may affect the effectiveness to identify children who might require further assessment (Brahler *et al*., 2012:83).

The BOT-2 short form is comprised of eight different subtests with a total of 14 different items and several focuses for each item (Bruininks & Bruininks, 2005:3). A detailed explanation of every subtest item can be found in Appendix G. The Fine Motor (FM) Precision and FM Integration subtests measure the precision of hand and finger movements, as well as VMI. Manual Dexterity is used to assess bimanual coordination with small objects. Bilateral coordination assesses body control and coordination of upper and lower limbs. The Balance subtest measures postural control and static and dynamic balance. Running speed and Agility assesses gait, while upper-limb coordination measures visual tracking and coordination of one's upper limbs. Lastly, the strength subtest measures trunk and upper and lower body strength. After administration of the BOT-2, the total motor composite is obtained (Bruininks & Bruininks, 2005:3). As seen in Figure 3.3, the total motor composite score is comprised of the above-mentioned subtests and subtest items.

The BOT-2 measures the following motor-area composites (Figure 3.3):

- Fine manual control: This includes tasks requiring control and coordination of hand and fingers during writing and drawing. This composite also comprises the Fine Motor Precision and Fine Motor Integration subtests (Bruininks & Bruininks, 2005:2).
- Manual coordination: The manual coordination composite includes control and coordination of the upper body during tasks, such as grasping and manipulating objects. The subtests under this motor composite include Manual dexterity and Upper-limb coordination (Bruininks & Bruininks, 2005:2).
- Body coordination: Body coordination measures motor skills involved in balance and coordination of upper and lower limbs. Bilateral coordination and balance are the two subtests assessed under this composite (Bruininks & Bruininks, 2005:2).
- Strength and agility: This comprise the control and coordination of muscles for upper body strength and locomotion. The subtests assessed are running speed and agility and strength (Bruininks & Bruininks, 2005:2).

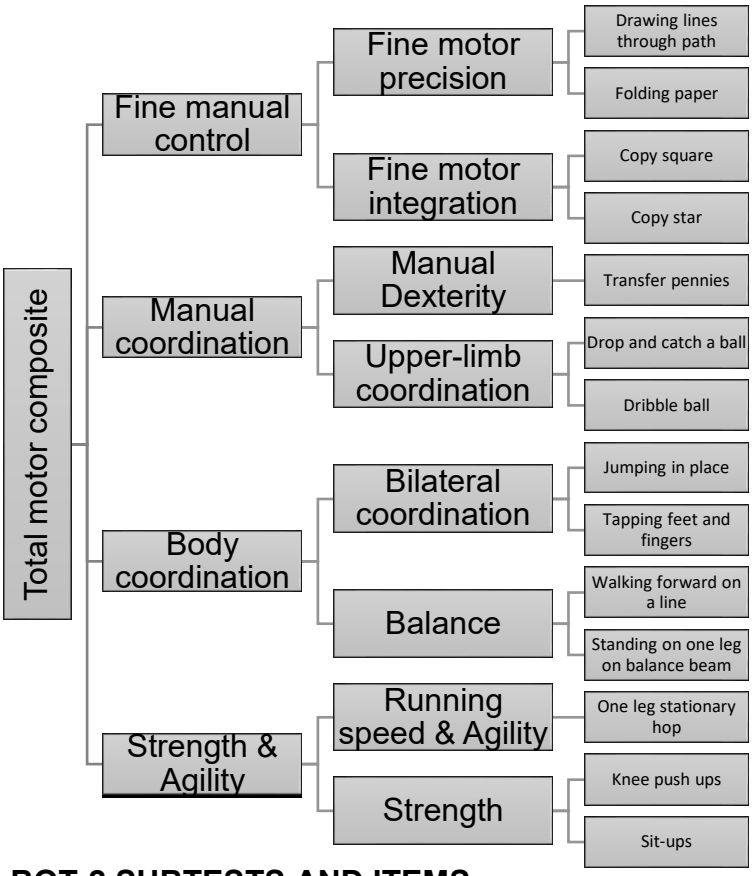

FIGURE 3.3: **BOT-2 SUBTESTS AND ITEMS**
Adapted from: Bruininks & Bruininks (2005:4).

Administration of BOT-2 (Short Form)

The BOT-2 is an individually administered test. According to Bruininks and Bruininks (2005:1), the test may only be administered by individuals qualified in occupational therapy, physical therapy and other related fields, and who have completed training in administration of the BOT-2. All assessors involved in the current study were trained and qualified to administer the test. The 14-item test provides measures of both gross and fine motor proficiency. The chronological age needs to be determined prior to test administration. This is obtained by subtracting the participant's birthdate from the testing date and is presented as years, months and days. The participant's hand and foot preferences should also be determined as many of the test items require the use of the participant's dominant hand and foot. The BOT-2 short form requires the following standardised equipment; pennies, penny pad, balance beam, knee pad, examinee booklet, tennis ball, pencil, stopwatch, tape measure and masking tape (Bruininks & Bruininks, 2005:2). Each subtest was explained and demonstrated clearly, and participants were given one practise round followed by one or two trials,

depending on the subtest requirements. The best score out of the two trials was then taken for the raw score (Bruininks & Bruininks, 2005:10).

Scoring

After administration of the BOT-2 short form, each item's raw score was converted to a point score using the conversion table on the record form. This allow the participant's item performance to be evaluated against a graded scale. Once each item's raw scores had been converted to point scores, the total point score was recorded by adding all the point scores. The point score for each subtest's items were also added and recorded. The overall total point score was then converted to a standard score and percentile rank by using gender and age specific norm tables. Standard scores were used to describe the participant's level of proficiency and related the participant's performance to a representative sample of individuals with similar ages. It gives an indication of how far the participant's score is from the mean score of population norms, taking into consideration the standard deviation in the population sample. The BOT-2 standard scores range from between 20 to 80, with a mean of 50 and standard deviation of 10. At any given age, if the standard score range is within one standard deviation of the mean, it includes 68% of the sample. If it is within two standard deviations, 95% of the sample is included and if it is within three standard deviations, 99% is included. Percentile ranks give an indication of the percentage of individuals that scored below the participant's score (Bruininks & Bruininks, 2005:11). The standard score was then used to obtain the descriptive category of the participant's scores (Table 3.3).

TABLE 3.3: **BOT-2 DESCRIPTIVE CATEGORIES**

Descriptive Category	**Standard score range**
Well-above average	70 or greater
Above average	60-69
Average	41-59
Below average	31-40
Well-below average	30 or less

Adapted from: Bruininks & Bruininks (2005:256).

Reliability

The reliability of a test refers to the reproducibility and the degree to which it produces consistent results. Reliability of the BOT-2 was examined using the following three measures: internal consistency; test-retest; and interrater reliability.

Internal consistency is used to determine the consistency of scores across each item of every subtest. Subtest reliabilities of the BOT-2 are high with a mean subtest reliability ranging between 0.80 to 0.90 (Bruininks & Bruininks, 2005:20).

Test-retest reliability is a measure to determine the consistency of a test over a certain time period. The BOT-2 reliability coefficients were determined using the Pearson correlation with a score of 0.80. A good test-retest reliability is between 0.70 to 0.80 (Bruininks & Bruininks, 2005:20).

Interrater reliability measures the consistency of scores obtained from different examiners with the same examinee. Interrater reliability on the BOT-2 are extremely high with a score of 0.97 (Bruininks & Bruininks, 2005:21).

Another study evaluated the BOT-2 Short Form on preschool children and determined that it had a high interrater validity of 0.90 and a test re-test reliability ≥0.80 (Venetsanau *et al*., 2009:544).

Validity

Validity is the degree to which tests measure what it sets out to measure and is one of the most important factors to consider in test development and assessment. Validity of the BOT-2 was measured using the following areas: 1) test content; 2) internal structure; 3) clinical group differences; and 4) relationships with other tests of motor skills (Bruininks & Bruininks, 2005:56).

Test content validity is determined by evaluating whether the content of the test is representative of the factors the test aims to measure. The BOT-2 demonstrates high content validity (Bruininks & Bruininks, 2005:57). Internal structure validity refers to the degree the relationships between the subtests conform to expectations. Inter-correlation coefficients between subtests can be found in the BOT-2 manual (Bruininks & Bruininks, 2005:61,62) in Tables 6.7, 6.8 and 6.9. Clinical group validity was also high in identifying motor performance deficits in individuals with various disabilities (Bruininks & Bruininks, 2005:65-68).

The BOT- 2 also demonstrated strong relationships with other measures, including the Peabody Developmental Motor Scales, Second Edition and the Test of Visual-Motor Skills-Revised (Bruininks & Bruininks, 2005:69-72).

The Beery-Buktenica Developmental Test of Visual-Motor Integration (Beery VMI) [Full form]

The Beery VMI full form is a standardised 30-item test used to measure the integration of visual and motor abilities of children aged 2 years to adulthood. The main purpose of the Beery VMI is to assess visual motor skills through copying geometric shapes (Beery & Beery, 2010:10). This tests certain abilities required for accurate handwriting, including shape recognition and use of vision controlling one's fine motor movements for accurate coordination of these movements (Duiser *et al*., 2014:78). It has been reported that the ability of the child to copy the first 9 shapes of the test can be used as a predictor of handwriting readiness and is an effective tool in measuring letter formation (Bara & Gentaz, 2011:746; Duiser *et al*., 2014:78).

Administration of the DTVMI

The test can be administered to individuals or groups and takes between 10 and 15 minutes. According to Beery & Beery (2010:17), only individuals qualified with a bachelor's degree in either psychology, education, human relations or other closely related fields, are allowed to administer the Beery VMI. All evaluators in the current study were qualified with a bachelor's degree in Sport Science or Honours degree in Kinderkinetics and were sufficiently trained in the use of the Beery VMI.

The recommended method of administration is 2 or more adults/supervisors with 20+ children at a time. Children in Grade 1 and above can be tested as an entire class together. In the current study, this procedure was followed (Beery & Beery, 2010:20). An average of 25 participants per class were evaluated together with a minimum of 3 supervisors who administered the test. This method allows for a more time- and cost-effective procedure, however this method is merely a screening tool and does not allow as much time to observe participants as with individual administration. Individual administration allows the examiner to observe the child's movements, pencil grip and behaviour attentively, whereas with group administration this is not always possible. However, as the current study did not aim to evaluate or observe participants' attitude,

body movements and other qualitative observations, this did not have an effect on the final results (Beery & Beery, 2010:20).

Testing for the Beery VMI occurred in the participants' classrooms at their school desks. After their desks were cleared from all obstacles and the room was quiet, the following testing procedure, as instructed by the manual, was followed (Beery & Beery, 2010:20,21).

1. The Beery VMI test booklets were handed out to the participants while they sat centred to their desk with the booklet closed in front of them.
2. The assessor explained the rules and demonstrated that the participants must copy the forms in the block provided below each item.
3. Participants were then instructed to open their booklets on the page where they had to start and had to copy the forms in the correct order, from left to right.
4. Only one attempt for each item was allowed.
5. Participants could move at their own pace through the booklet and used sharpened HB pencils to complete the test (with no eraser).

Throughout the test, the supervisors moved around the classroom to observe the participants and encourage them if they needed encouragement.

Scoring

After completion of the test, the participant's chronological age was calculated. One point was allocated for each correctly copied form and 0 for every incorrect attempt. Scoring was done up to three consecutive failures, which indicates that the ceiling level was reached. The scoring criteria for each item can be found in the Beery VMI test manual (Beery & Beery, 2010:30-79). Beery & Beery (2010:28), explains that when the examiner is in doubt about the item when scoring, rather score it as meeting the criteria.

The first 3 items of the Beery VMI are spontaneous scribblings and are only administered to children younger than 5 years old. In the current study, these items were not administered because all the children were between 6 to 7 years of age and, therefore, participants automatically received a score of 1 for all 3 items (Beery & Beery, 2010: 27). This was also the participants' basal level.

The raw score was obtained by adding all the correct attempts which were converted to norm-based standard scores, percentiles and age equivalents using the test manual guide (Beery & Beery, 2010:26). The standard score was then used to obtain the performance category the participant score represents (Table 3.5). The current study used the standard scores and performance category to report the results.

TABLE 3.4: **Beery VMI PERFORMANCE CATEGORIES**

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

Adapted from: Beery & Beery (2010:94).

Reliability

Three areas of consistency were measured when the reliability of the Beery VMI was considered: 1) content/internal consistency; 2) test-retest reliability; and 3) inter-scorer reliability (Beery & Beery, 2010:103).

The Rasch-Wright analysis was used to measure the content consistency. Results indicated high content reliability with total group item separation of 1.00 and total group person separation of 0.96 (Beery & Beery, 2010:103). The Spearman-Brown analysis showed good internal consistency with 0.95 across all age groups (Beery & Beery, 2010:104). The overall test-retest coefficients were 0.88 for the Beery VMI. A group of 100 participants were tested and scored by two individuals to determine the inter-scorer reliability. A high inter-scorer reliability of 0.93 was found (Beery & Beery, 2010:108).

Validity

For a test to be considered valid, the following areas must be considered: 1) content validity; 2) concurrent validity; 3) construct validity; and 4) predictive validity (Beery & Beery, 2010:111).

Content validity refers to the degree to which the content of the test is representative of the outcomes the test is required to assess. The Rasch-Wright analysis method revealed strong content validity (Beery & Beery, 2010:111).

Concurrent validity is measured by comparing the results of one test with those of other similar tests. The Beery VMI correlated with a score of 0.75 with other tests evaluating VMI skills (Beery & Beery, 2010:112).

Predictive validity of the Beery VMI has been proven by various studies. The Beery VMI has been found to be an accurate predictor of academic achievement (Beery & Beery, 2010:120,122).

Construct validity is determined by identifying several constructs believed to be underlying factors of the test and then generate and verify a hypothesis based on these constructs. According to the Beery VMI, the following constructs were identified and confirmed: 1) results are related to chronological age; 2) the results from the Beery VMI and its supplemental tests correlate well with one another; 3) the Beery VMI is more challenging than its supplemental tests; 4) the Beery VMI correlates well with other non-verbal intelligence tests; 5) the results from the Beery VMI correlates well with academic achievement test results; 6) the Rasch-Wright item and person separation indices are high; and 7) the Beery VMI results are affected by certain disabilities (Beery & Beery, 2010:112,113).

ESSI Reading and Spelling Test

The ESSI is a standardized reading and spelling test available in English and Afrikaans. The ESSI reading and spelling test consists of a series of 28 vocabulary lists, based on the South African curriculum for Afrikaans and English-speaking learners in Grades 1 to 7. Children are required to read and spell these words within a specific timeframe (Esterhuyse, 2002:1).

Administration

- *ESSI Reading:* This test was individually administered in a quiet room without any distractions. The evaluator explained to the participant that he/she should read the word shown on the scoring paper. Participants were required to read the word quickly without any delay. They were not allowed to spell out the word when they read it but had to read it in one fluent motion. The test was stopped when the participant could not read, or spelled out (for example, dog: d-o-g) 3 words consecutively (Esterhuyse, 2002:4).
- *ESSI Spelling:* This test was administered in a class setting. One assessor read out the words to the class (25 participants), while 3 assessors walked around the room to observe the participants. The test papers were handed out to the participants together with a pencil. Only after all obstacles and books were cleared from their desks, did the assessor explain the test to them. One word at a time was read out to the class, which they had to write down on their paper. The next word was only read out after every child completed the previous word. A mark was only allocated if the word was spelled correctly and every letter was formed correctly (letters not reversed or confused) (Esterhuyse, 2002:4).

Scoring

After completion of the two tests, 1 mark was allocated for a correct response and 0 for an incorrect response. Scoring was stopped after 3 consecutive failed attempts. Results were summated to determine the raw score, which was converted to a stanine by using the norm table. Norms were calculated according to the individual's Grade, as well as the school term they are currently in. The stanine scale is a normalised standard scale, which provides standard score ranging from 1 to 9 with a mean of 5 and a standard deviation of 1.96. The stanine score was then used to determine the descriptive category for each participant (Esterhuyse, 2002:7). Table 3.5 illustrates the descriptive category for each stanine score.

TABLE 3.5: **ESSI READING AND SPELLING TESTS DESCRIPTIVE CATEGORIES**

Stanine	Description
1	Very poor
2	Poor
3	
4	Average
5	
6	
7	Good
8	
9	Very good

Adapted from: Esterhuyse (2002:7).

Reliability and Validity

The ESSI Reading and Spelling tests have been found to have good reliability r=0.85 (Spelling) and r=0.90 (Reading) for Grade 1 learners. Content validity was ensured by involving experienced teachers in the identification of the words (Esterhuyse, 2002:17-19).

Intervention

The 12-week perceptual-motor intervention programme was planned by the main researcher, who is a qualified Kinderkineticist (01/017/11/1718/005), registered with the South African Professional Institute for Kinderkinetics (SAPIK). The intervention focused primarily on perceptual-motor skills and incorporated letters and words into the activities.

The main foci of the perceptual-motor intervention were: body awareness; spatial awareness; temporal awareness; directionality; laterality; bilateral coordination; tactile stimulation; midline crossing; proprioception; and core strength. Activities also involved children identifying and drawing letters. The intervention occurred twice per week consisting of 60-minute sessions. Participants were divided into 3 groups, which they remained in for the entire intervention period. Each group had a presenter that remained with them throughout every session for the entire duration of the intervention to ensure consistency. The presenter explained and assisted the participants throughout each activity. Every session consisted of a 7-minute proprioceptive activity, followed by an 8-minute warm-up, 4 activities (each consisting of 10 minutes), and a 5-minute cool down. Proprioceptive stimulation was done before every session, which

consisted of a deep pressure body map massage to integrate information from various senses and to get the participants calm and focused for the session (De Jager & Victor, 2013). A detailed description of the perceptual-motor programme, as well as equipment used, is presented in Appendix H-K.

Interventions based on the Dynamic Systems Theory

As mentioned in Chapter 2, the Dynamic Systems Theory proposes that learning occurs due to an interaction of multiple systems within the person, task and environment (Thelen, 1989:947). Each of these components affects and is affected by each other (Cote, 2015:158). The following three constraints were considered in the current study (Holt *et al.,* 2010:448):

- Task constraints relate to the difficulty level of a specific task, test or activity and whether the child's skill level is adequate to perform the task (Thelen, 1989:948). In the current study, task constraints involved the perceptual-motor skills and gross and fine motor skills required to complete the task.
- Individual constraints can be categorised into structural constraints, relating to individual's anatomic structure and functional constraints, which comprise the child's physical and cognitive skill constraints (Holt *et al*., 2010:448). Functional constraints in the current study included the child's upper body strength, coordination, as well as their attention level, intrinsic motivation and intellectual abilities.
- Environmental constraints refer to all the extrinsic factors that may have an influence on the child (Holt *et al*., 2010:448). In the current study, factors that might have had an influence on the child's movement skills included the weather, the presenters, how the child functioned in a group, as well as any distractions that might have hindered the child.

Type of intervention approach

An integrated approach (Top-down and Bottom-up), was used in the current study. The process orientated, bottom-up approach aims to improve the child's underlying skills, which in turn will improve his or her ability to perform a specific motor task. These underlying systems include sensory functions, attention and planning, which are all prerequisites for motor skill execution (Kennedy *et al*., 2013:45). The current

study applied the bottom-up sensory-motor integration, as well as a perceptual-motor training approach. Sensory-motor integration aims to promote improved motor development and higher cortical thinking by stimulating and integrating the child's senses (Auxter *et al*., 2010:168). Perceptual-motor training was also applied, because it focuses on the development of perceptual-motor skills, which will then build a sufficient foundation for more complex cognitive skills (Pienaar, 2017). This approach targets components such as laterality, balance, body awareness, visual perception, hand-eye-coordination, as well as locomotor skills. It enables children to develop body control, a positive self-image, as well as greater academic performance (Johnstone & Ramon, 2011:20). The product-orientated, top-down approach aims to improve the end-product or the specific skill. The current study applied the task-specific method, which focuses on the direct learning of the skill. It involves breaking down the skill into parts and learning each part separately (Auxter *et al*., 2010:168). Skills such as letter recognition and letter formation were developed using this approach.

SUMMARY

The purpose of the study was to determine the effects a perceptual-motor intervention had on the motor proficiency and letter knowledge of selected Grade 1 children, as well as to determine the relationship between the two variables. A quasi-experimental design was implemented in which a sample of 100 (N=100) Grade 1 children was randomly assigned into a control and experimental group. All participants were pre- and post-tested using the BOT-2, to test motor proficiency, DTVMI, to evaluate their VMI skills and the ESSI Reading and Spelling tests to evaluate their reading and spelling abilities. The experimental group participated in a 12-week perceptual-motor intervention. Repeated measures ANOVA and the Pearson-product correlation were used to establish cause-and-effect measures and to determine the relationship between the different variables. After the post-tests were completed the final sample size was 97 (N=97). The results are presented in the chapters that are to follow.

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CHAPTER 4

RESEARCH ARTICLE 1
THE EFFECT OF A PERCEPTUAL-MOTOR INTERVENTION ON LETTER KNOWLEDGE OF SELECTED GRADE 1 CHILDREN

Referencing and formatting within the chapter and the list of references at the end thereof has been done in accordance with the guidelines of the Perceptual and Motor Skills Journal (included in Appendix A). Consequently, the referencing and formatting style used in this chapter may differ from that used in the other chapters in this thesis. This article has been submitted for consideration in the Perceptual and Motor Skills Journal.

The effect of a perceptual-motor intervention on letter knowledge of selected Grade 1 children

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Abstract

The decrease in physical activity opportunities in schools has negative implications on children's physical health, as well as their school performance. In order to promote physical activity and academic performance effectively, it is important to combine learning with movement. The aim of this study was to determine the effect a perceptual-motor intervention on the participants' letter knowledge. The total sample consisted of Grade 1 learners (N=100) from two selected schools in the Western Cape, South Africa. In each school, one Grade 1 class was randomly assigned to the control group and another to the experimental group. The Beery-Buktenica Developmental Test of Visual-Motor Integration (Beery VMI) and the ESSI Reading and Spelling Tests were used to assess the children's Visual-motor integration (VMI) and reading and writing skills. The study included a 12-week perceptual-motor intervention performed by qualified Kinderkineticists. Repeated measures ANOVA were used to examine the effects of the intervention on the outcome measurements. A significant difference was found between the experimental and control groups from the pre- to post-test in the participants' VMI, reading and writing scores ($p \leq 0.05$). The perceptual-motor intervention is thus an effective way to improve children's reading, writing and VMI skills. It allows children to be active while learning, thus reducing sedentary time, while upholding educational standards. Future interventions in this field should be developed in collaboration with teachers to allow for a more holistic approach to children's academics and physical activity.

Keywords

Perceptual-motor intervention, Beery VMI, ESSI Reading and Spelling test, letter knowledge.

Introduction

Physical activity in schools has steadily declined in recent years due to the increased focus on academic tasks and as a result children spend the majority of their school day sedentary (Bartholomew et al. 2018). This, not only has health implications, but also contributes to poorer academic performance and concentration (Donnelly & Lambourne, 2011; Milne, Caciotti, Davies & Orr, 2018). Evidence suggests that the combination of movement with learning is an effective way in promoting physical activity and academic performance (Bartholomew & Jowers, 2011; Donnelly & Lambourne, 2011; Norris, Shelton, Dunsmuir, Duke-Williams & Stamatakis, 2015; Mullender-Wunsma et al. 2016).

Movement and cognition

Gross motor movements are associated with numerous academic skills, including interpreting letters, words and writing (McClelland, Pitt & Stein, 2015). According to the embodied cognition theory, information is acquired through both perception and movement, and therefore, cognition is reliant on the physical body. This theory explains that abstract concepts are linked with the body's sensory and motor systems (McClelland et al. 2015; Fugate, Macrine & Cipriano, 2018). Therefore, it could be assumed that the body itself is actively involved during learning and academic tasks such as reading and writing.

Nilukshika, Nanayakkarawasam and Wickramasinghe (2012) explains that the foundation of good handwriting is the integration of gross, fine and visual motor integration (VMI) skills. As most academic tasks require well-developed fine motor skills, it is important to understand the factors that influence these skills.

The muscles responsible for gross motor skills have a big influence on the muscles required for fine motor skills. Therefore, only after a strong foundation of gross motor skills is established will the development of fine motor skills, such as writing, occur (Flatters et al. 2014; Bara & Bonneton-Botte, 2018). To be able to read and write, the brain utilises existing

information obtained from sensory input, perceptual processing and motor control. It is believed, therefore, that the brain can only develop intellectual capacity once the child has learned to control his or her physical actions and sensorimotor maps have been stored in the brain (McClelland et al. 2015).

Gross motor skills that have an effect on fine motor and cognitive tasks include muscle tone, strength, balance, coordination and bilateral integration (El-Dayem, Salem & El-Hadidy, 2015). Studies suggest that there is a correlation between gross motor and cognitive skills as they have similar developmental patterns. There is a sudden increase in both gross motor and cognitive skill development between the ages of five and 10 years (Van der Fels et al. 2015). Moreover, neuro-imaging evidence indicates that certain brain regions (prefrontal cortex, cerebellum and basal ganglia), responsible for motor and cognitive activities, are co-activated during certain tasks (Carlson, Rowe & Curby, 2013; Fernandes et al. 2016). This occurs especially if a task is either complex or new or when concentration is required to perform the task (Carlson et al. 2013).

Letter knowledge and perceptual-motor skills

The ability to read and write is essential for children to achieve academic success. An important aspect of a child's literacy development is the acquisition of letter knowledge which is comprised of two interacting skills, known as letter recognition and -formation (Bara & Bonneton-Botté, 2018). One of the first steps in learning to read and write is grasping the skill of letter recognition (Kersey & James, 2013). To be able to read, the child has to quickly and accurately name or identify a letter and then place them together to form a word (James & Engelhardt, 2012; Kersey & James, 2013). Furthermore, handwriting or letter formation, is a multifaceted skill which requires a complex integration of cognitive, sensory and perceptual motor components, such as visual motor integration, motor planning, motor proficiency, hand-eye coordination and proprioceptive feedback (Rosenblum, Parush, Epsztein & Weiss, 2003).

Letter formation involves an integrated pattern of coordinated movements which depend on visual perception, as well as sensorimotor feedback (Capellini, Giaconi & Germano, 2017).

Letter knowledge is known as a perceptual motor skill due to the interaction between perception and motor output. Reading and writing requires the child to process and apply perceptual information such as the size, location, orientation and angles of the letter (Finkbeiner & Coltheart, 2009; Kersey & James, 2013). Visual perception is an important aspect of letter knowledge as it involves the ability to recognize similarities and differences in forms, as well as to copy lines and shapes (Van Hoorn, Maathuis, Peters & Hadders-Algra, 2010). Subcomponents of visual perception include VMI, form consistency, depth perception, figure-background perception and visual closure (Pienaar, 2017). Several studies have found that perceptual motor deficits have a negative impact on reading and writing skills and that perceptual motor skills are strongly related to gross and fine motor skills (Wuang, Wang, Huang & Su, 2009; Erasmus, Janse van Rensburg, Pienaar & Ellis, 2015; Bara & Bonneton-Botté, 2018). Handwriting, is therefore, enhanced by intensifying the motor experience and adding a sensory component (James & Engelhardt, 2012). By making writing a sensorimotor experience, learning is enhanced as letters are stored in the child's long-term memory (Zemlock, Vinci-Booher & James, 2018). By physically interacting with the environment through movement, the sensory and motor systems are stimulated, thereby developing a clearer visual image and enhancing letter recognition performance (James, 2010).

Previous interventions

Previous studies that have investigated the effect of perceptual-motor intervention mostly focused on overall cognitive functioning and school readiness skills (Pienaar, Van Rensburg & Smit, 2011; Erasmus et al. 2015). These studies concluded that perceptual-motor interventions are beneficial for children's visual perception, language and other cognitive abilities such as attention (Pienaar et al. 2011; Erasmus et al. 2015). Moreover, several other studies have

investigated beneficial ways of improving reading and writing skills in children. The sensorimotor approach was found to be an effective reading and writing intervention when incorporating letters with sensory stimulation. However, these studies only focused on fine motor tasks and did not incorporate any gross motor skills or physical activity (Denton, Cope & Moser, 2006; Weintraub et al. 2009). Alternatively, other studies have explored programmes using physical activity as a means to improve school performance. Significant improvements were found in participants' letter recognition, attention and other cognitive tasks (McClelland et al. 2015; Mullender-Wijnsma et al. 2016; Bara & Bonneton-Botte, 2018). Bara and Bonneton-Botte (2018) concluded that learning letters through gross motor movements proved more effective than merely writing letters by hand (fine motor skills). Therefore, it could be assumed that by incorporating gross motor skills in perceptual-motor training will be an effective method of improving children's letter knowledge skills.

Perceptual-motor intervention

Perceptual-motor training is beneficial for reading and writing because it assists the child in learning to control his or her body coordination, spatial orientation, directionality, manual dexterity and object manipulation. Essential perceptual-motor skills that relate to letter knowledge include: spatial and directional awareness; visual perception; body awareness; and temporal awareness (Kersey & James, 2013). It is effective to incorporate these skills through gross motor skills because these movements are believed to transfer to fine motor skills (Bara & Bonneton-Botté, 2018). By printing and tracing letters, the motor cortex part of the brain is activated, which is also the area of the brain that is active during any perceptual motor task (James & Engelhardt, 2012). When a motor movement is learned and a motor programme is stored, the visual cortex is activated, which increases retrieval of information (Kersey & James, 2013).

The current study aimed to determine the effect of a perceptual-motor intervention on the cognitive skills of children, specifically letter knowledge. Activities in the current study incorporated gross motor skills with letters by forming and tracing letters in various ways, including with their bodies, with different objects, such as ropes and drawing big versions of letters. Sensorimotor stimulation was added in activities by incorporating physical activity into visual academic lessons to ensure that the neural pathways for each letter and movement were strengthened (Vinter & Chartrel, 2010). Children gain knowledge from sensory stimulation because their nervous system integrates the information more efficiently (Weintraub *et al*., 2009; Mullender-Wijnsma *et al*, 2016). The proprioceptive information obtained from the movements gives the child an awareness of the position of his or her limbs in relation to the rest of their body, thereby improving the coordination of handwriting movements (Denton *et al*, 2006). To perform smooth, purposeful and accurate movements, such as in writing, there must be a simultaneous functioning of sensory input, cognitive functioning and motor output (Pienaar, Barhorst & Twisk, 2013).

Methodology

Overview

The participating schools were selected by means of convenient sampling because of their proximity and for logistical reasons, and therefore, the research design can be typified as quasi-experimental. Participants from two schools were randomly assigned to experimental and control groups. Both groups participated in a 2-week pre-test period, where after the experimental group participated in a 12-week perceptual-motor intervention. The control group continued with their normal school day and did not participate in any of the intervention activities. Post-tests were conducted on both groups after the 12 weeks to assess what effect the intervention had on the experimental group.

Participants

Schools were conveniently selected from the Bellville (School A) and Stellenbosch (School B) areas in the Western Cape Province, South Africa. The sample consisted of Grade 1 learners (N=100) between the ages of 6 to 7 years. Two Grade 1 classes from each school were selected to participate in the study. One Grade 1 class from each school was randomly assigned to the experimental group and the other Grade 1 classes from each school were randomly assigned to the control group by an independent third party. School A consisted of 62 participants, with 30 learners in the experimental group and 32 in the control group. School B consisted of 38 participants, with 20 participants in the experimental group and 18 in the control group. After the post-test, 2 participants were excluded from the experimental group due to health reasons and 1 participant was excluded from the control group due to non-attendance. Therefore, the final sample size was 97 Grade 1 learners (N=97).

Instruments

The Beery-Buktenica Developmental Test of Visual-Motor Integration (Beery VMI) is a standardised test used to measure the integration of visual and motor abilities of children aged two years up to adulthood. The main purpose of the Beery VMI is to assess visual motor skills by means of copying geometric shapes (Beery & Beery, 2010). This tests certain abilities required for accurate handwriting, including the ability to recognize shapes, use vision to control one's hand, arm and finger movements and to coordinate these movements accurately (Duiser, Van der Kamp, Ledebt & Salvensberg, 2014). It has been reported that the Beery VMI can be used as a predictor of handwriting readiness and is an effective tool in measuring letter formation (Bara & Gentaz, 2011; Duiser *et al*., 2014). An average correlation of r=0.42 between the Beery VMI and handwriting performance has been recorded (Beery & Beery, 2010). The administration of the test was done in a group class setting with a minimum of 3 supervisors. According to Beery and Beery (2010), this is an acceptable administration method

to screen whether further assessment is needed. After completion of the test, raw scores are converted to norm-based scaled scores, percentiles and age equivalents using the test manual guide (Beery & Beery, 2010). The standard score was then used to obtain the performance category the participant's score represents. The performance categories range from 'Very high', which represents a score of more than 129, to 'Very low', which represents a score below 70. The Beery VMI has been found to have good construct validity for measuring VMI skills, with an inter-rater reliability of r=0.93 (Beery & Beery, 2010).

The ESSI Reading and Spelling test is a standardized test available in English and Afrikaans. This assessment consists of a vocabulary list, which is based on the South African environment. The ESSI Reading and Spelling test consists of a series of 28 vocabulary lists for Afrikaans- and English-speaking learners in Grades 1 to 7. Children are required to read and spell these words within a specific timeframe (Esterhuyse, 2002). After completion of the reading and spelling tests, a score of 1 was allocated to a correct response and 0 to an incorrect response. Results were summated to determine the raw score, which is converted to a stanine by using the norm table. Norms were calculated according to the individual's school Grade, as well as the school term he or she is currently in. The stanine score was then used to determine the descriptive category of the participant, which ranges from 'Very good' (a score of 9) to 'Very poor' (a score of 1 and below). The stanine scale is a normalized standard scale, which provides standard scores ranging from 1 to 9 with a mean of 5 and a standard deviation of 1.96. The ESSI Reading and Spelling tests have been found to have good reliability r=0.85 (spelling) and r=0.90 (reading) for Grade 1 learners. Content validity was ensured by involving experienced teachers in the identification of the words (Esterhuyse, 2002).

Procedure

The primary researcher obtained permission from the Western Cape Education Department (WCED), as well as the Research Ethic Committee of Stellenbosch University (REC-2018-

7126). Permission was obtained from the principals and teachers of each school and parents received a written description of the study and signed a written informed consent form. Every participant received a verbal and written explanation of the study and was given the choice to participate by signing an assent form. Furthermore, ethical concepts such as autonomy, beneficence, non-maleficence, respect for anonymity and confidentiality were considered and strictly adhered to.

Data was collected by qualified Kinderkinetici[3], as well as Kinderkinetics Honours students who were trained by the main researcher to conduct the DTVMI and the ESSI Reading and Spelling tests. At pre- end post-test, each child was assessed by the same person to ensure reliability across measurements.

The study was triple blinded because the intervention was unknown to: (a) the research participants; (b) the individuals who administered the intervention; and (c) the assessors. Kinderkinetics Honours students, who were not involved in the testing, administered the intervention. The students had no prior involvement with the participants and had no knowledge about their performance in the assessments.

The 12-week perceptual-motor intervention focused primarily on perceptual-motor skills that incorporated letters and words into the activities. Activities were planned by the primary researcher who also trained the Kinderkinetics Honours students who presented the intervention. The main focus of the intervention was: body awareness; spatial awareness; temporal awareness; directionality; laterality; bilateral coordination; tactile stimulation; midline crossing; proprioception; and core strength. Activities also involved identifying and drawing letters. Proprioceptive stimulation was performed before every session, which

3 Kinderkinetics is a profession that focuses on the neuro-motor development of children between the ages of 0-13 years through scientifically designed gross motor programmes.

consisted of a deep pressure body map massage to integrate information from various senses and to calm and focus the participants for the session (De Jager & Victor, 2017). The intervention took place twice a week and the sessions lasted for 60 minutes. Participants were divided into 3 groups, which they remained in for the entire intervention period. Each group had a presenter who remained with them throughout every session for the entire duration of the intervention. This was to ensure consistency throughout the intervention. The presenter explained and assisted them through each activity. Every session consisted of a 7-minute proprioception stimulation exercise, followed by an 8-minute warm-up, 4 activities (each consisting of 10 minutes) and a 5-minute cool down.

Data analysis

All data was analysed by Professor Martin Kidd, Director of the Statistical Consultation Centre at Stellenbosch University by using Statistica®, version 13.5.0.17. Repeated measures ANOVA was applied to examine the effects of the intervention on the outcome measurements. In this model the participants are included as random effects and group (experimental or control), time (pre- or 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 are reported and a 95% ($p<0.05$) confidence interval was used as a guideline for significant results.

Results

The total sample group (N=97) had a mean age of 7 years. The figures and data presented below illustrate the mean, mean difference and p-values for the DTVMI, ESSI Reading and Spelling tests for both the experimental and control groups. Results that are more detailed can be found in Appendix 1.

Beery-Buktenica Developmental Test of Visual-Motor Integration

As indicated in Figure 1, a statistically significant difference[4] ($p \leq 0.05$) in the average Beery VMI scores was found between the experimental and control groups from pre- to post-test. The mean scores of the experimental (95.64±10.21) and control (94.40±10.56) groups were fairly similar during the pre-test. The experimental group significantly improved ($p=0.00000$) with a mean difference of 15.74 points and a mean score of 111.38±9.46, whereas the mean score of the control group decreased slightly (93.45±12.03).

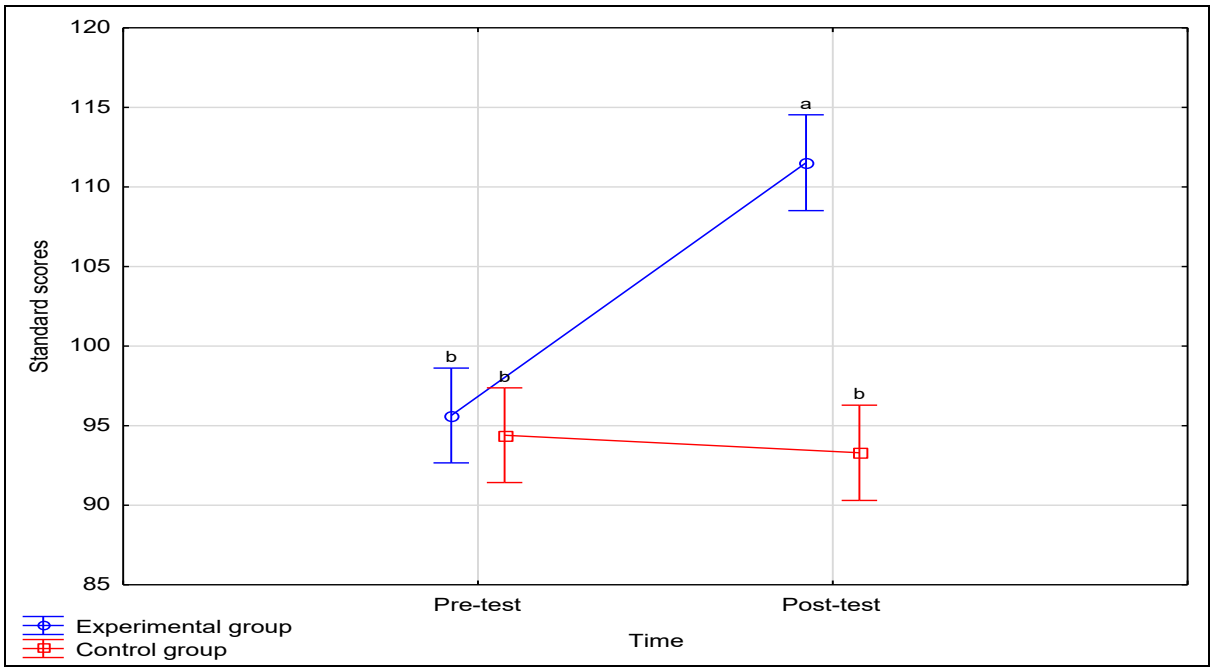

Figure 1. Beery VMI results for the experimental and control groups

Figure 2 illustrates the Beery VMI performance category changes from pre- to post-test for the experimental group. During the pre-test, 75% of the group scored in the average category. After the intervention, an improvement was found in the above average and high categories and the majority of participants (97.8%) scored in the average and above average categories.

[4] Statistical significance is represented in the graphs by using letters 'a', 'b' and 'c'. Note that if the letters differ between the 2 groups (a and b/c), it is an indication that there is a statistically significant difference between the groups. If the letters differ from pre- to post-test, it represents that the group has shown statistically significant improvement within in the group. However, if the letters remain the same between the groups or from pre-to post-test, no statistically significant results were found.

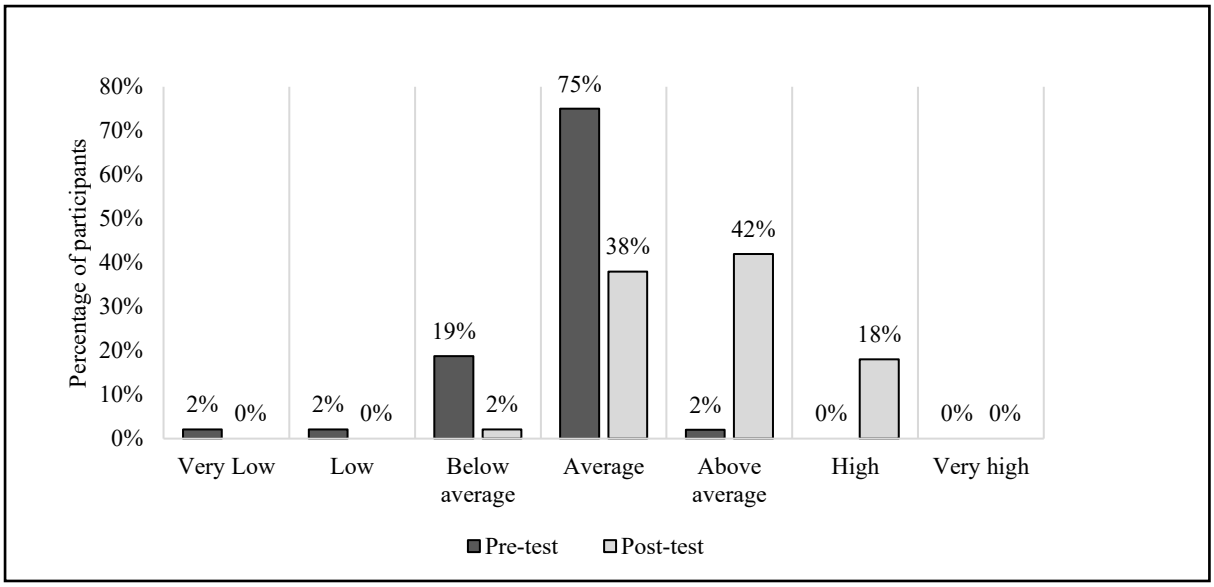

Figure 2. Performance categories for Beery VMI

ESSI Reading test

In Figure 3, a statistically significant difference in the average ESSI reading stanine scores between the experimental and control groups ($p \leq 0.05$) between pre- and post-test can be found. Before the intervention, the control group (4.16±2.25) scored significantly higher ($p=0.00000$) than the experimental group (2.74±1.29), whereas after the intervention the experimental group (5.49±2.11) scored significantly higher ($p=0.00000$) than the control group (4.39±2.2). The ESSI reading scores of the experimental group improved with a mean difference of 2.75, whereas the control group improved marginally with a mean difference of 0.23 from pre- to post-test.

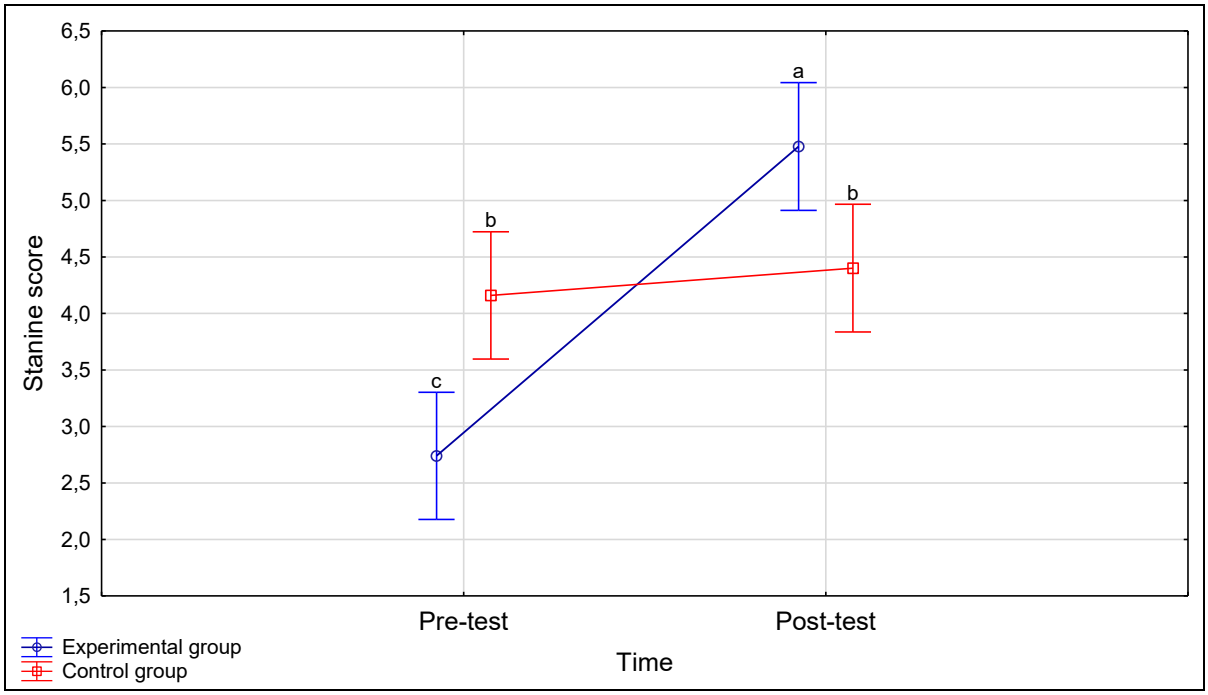

Figure 3. ESSI reading results for experimental and control groups

The performance category changes from pre- to post-test for the ESSI reading test can be found in Figure 4. After the 12-week intervention, there was an improvement in the average-, good- and very good categories of the experimental group. Additionally, it can be observed that before the intervention, 25% of the participants scored in the very poor category, whereas after intervention none of the participants scored in this category. Before the intervention, the ESSI reading results indicated that only 33% of the experimental group scored in the average category, whereas after the intervention, 73% scored in the average and higher categories.

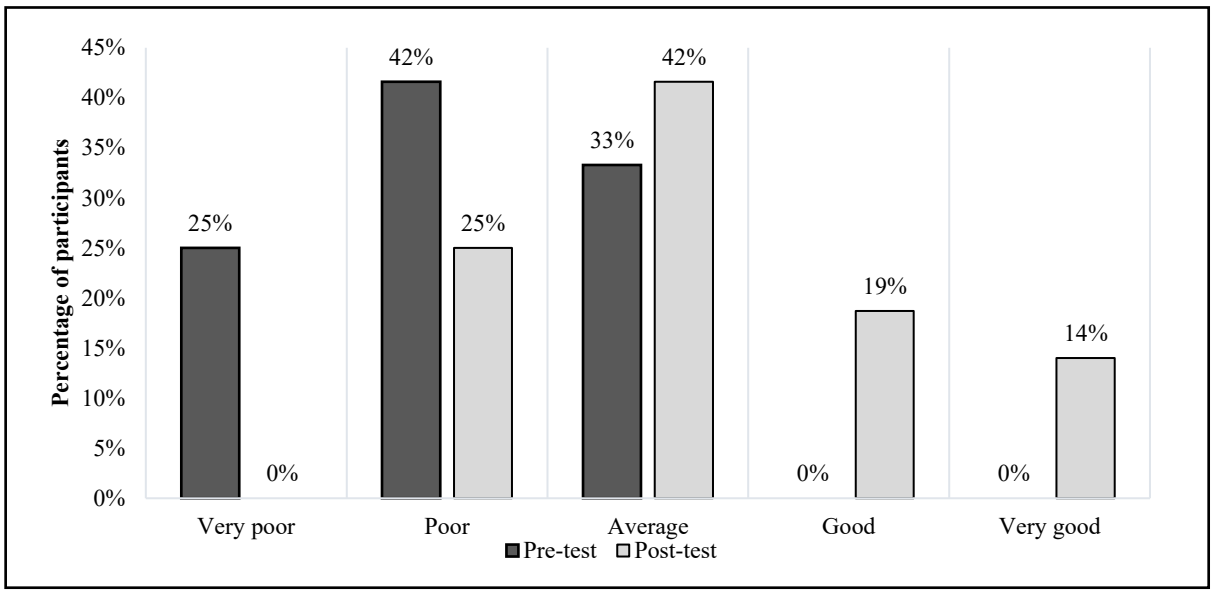

Figure 4. Performance categories for ESSI reading test

ESSI Spelling test

The ESSI spelling scores (Figure 5) illustrate a statistically significant difference ($p \leq 0.05$) in the average stanine scores from pre- to post-test between the experimental and control groups. There was no statistically significant difference between the two groups at the pre-test. The experimental group had a mean score of 3.48±1.29 and the control group had a mean score of 3.88±2.25. The experimental group obtained a mean post-test score of 5.49±2.11 and showed a statistically significant improvement with a mean value of 2.01 ($p=0.00000$). The control group, however, only improved slightly, with a mean score of 4.22±2.23, improving with 0.34 points.

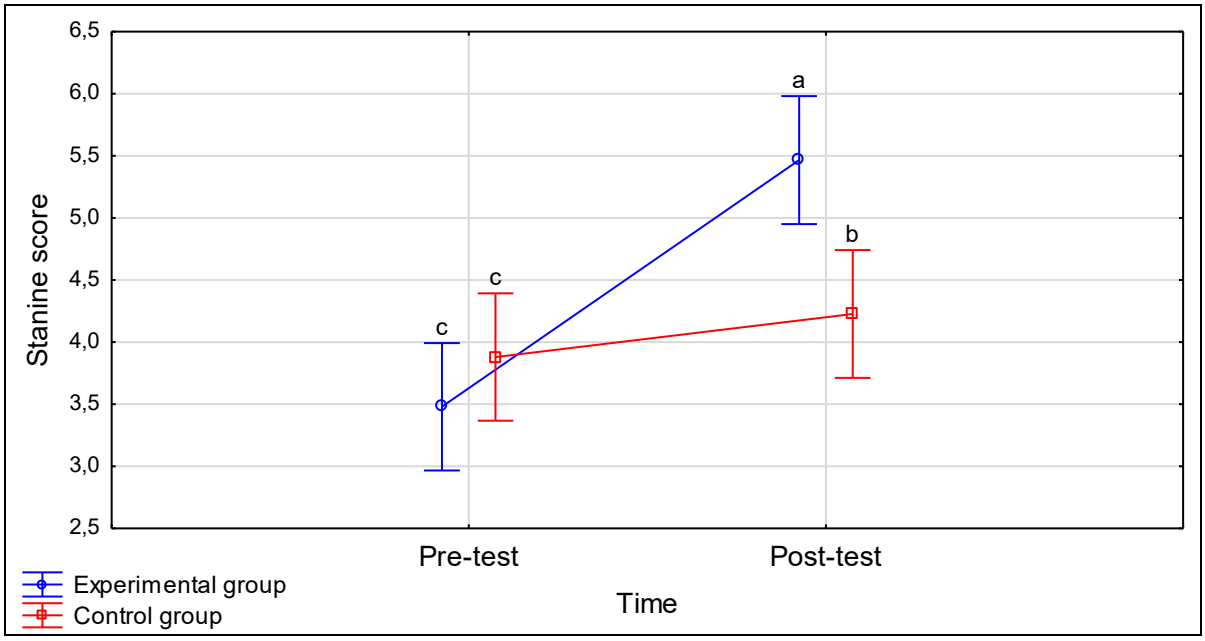

Figure 5. ESSI spelling results for experimental and control groups

Improvement was observed in the ESSI spelling performance categories in the average-, good- and very good categories. During the pre-test, 54% of the participants in the experimental group scored in the average and higher categories and after the intervention, 83% scored in the average and higher categories (Figure 6).

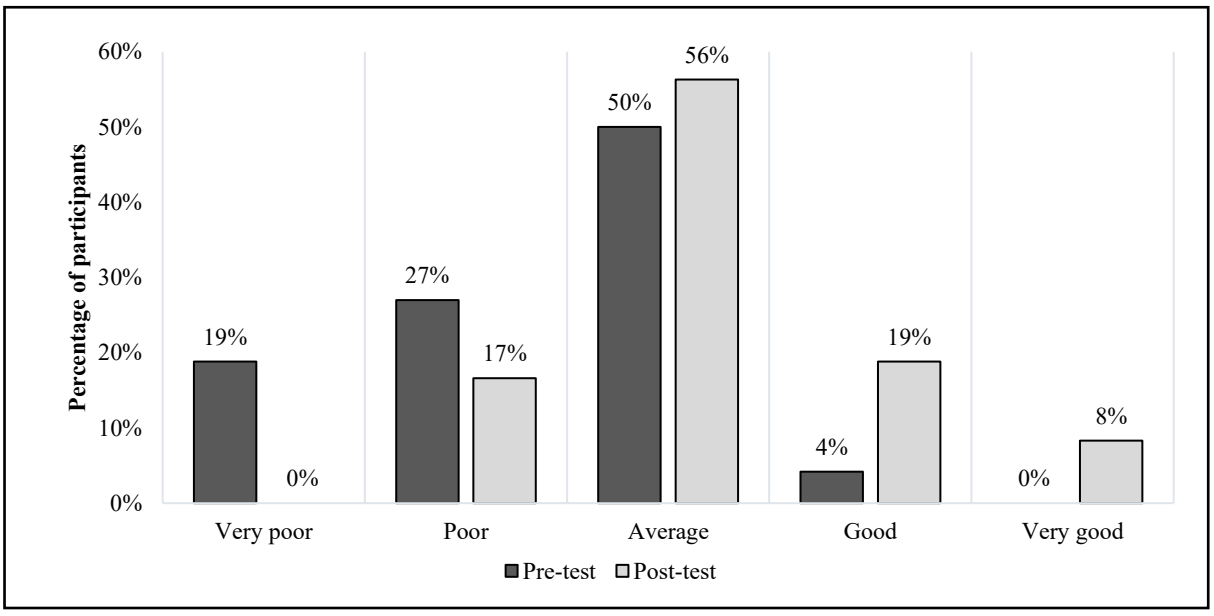

Figure 6. Performance categories for ESSI spelling test

Discussion

The current study investigated the effect of a perceptual-motor intervention on Grade 1 children's letter knowledge skills. A statistically significant improvement in overall reading, spelling and VMI scores after the 12-week intervention was found. This confirms the relationship between physical activity and academic performance. The results are in agreement with previous studies indicating similar results (Bara, Gentaz & Colé, 2007; Bara & Gentaz, 2011; Bartholomew & Jowers, 2011; Erasmus et al. 2015; Kersey & James, 2013; Mullender-Wijnsma et al. 2016; Bara & Bonneton-Botté, 2018; Bartholomew et al. 2018).

Results from the Beery VMI indicated a statistically significant difference between the experimental and control group. As mentioned previously, the Beery VMI is an effective measuring tool to predict letter formation and handwriting performance (Beery & Beery, 2010). From that data collected it could be suggested that the perceptual-motor intervention significantly improved the handwriting quality and performance of the participants. Moreover, VMI is an important perceptual-motor skill for both handwriting and reading skills of children (Pagani & Messier, 2012; Pienaar et al. 2013). VMI skills are imperative for a child to be able to copy letter formations (Dinehart, 2015). If a child has poor form constancy (sub-component of visual perception), he or she would find it difficult to identify errors in letter formation (Prunty, Barnett, Wilmut & Plumb, 2016). They will also struggle with reading because they cannot recognise each word separately (Julius, Meir, Shechter-Nissim & Adi-Japha, 2016; Pienaar, 2017). Difficulties copying and producing letters of appropriate shapes and sizes may be attributed to poor figure-ground perception or visual closure (Prunty et al. 2016). The current study included various movement activities that involved perceptual-motor skills related to letter recognition and -formation such as spatial awareness, directionality and visual perception. By focusing on these underlying skills through gross motor activities, it is transferred to the child's fine motor and cognitive skills.

This is in agreement with results from another South African study done by Pienaar et al. (2013). She indicated that there is a strong relationship between reading, writing and VMI skills. The study concluded that perceptual-motor abilities should be critical building blocks for academic achievement in reading and writing (Pienaar et al. 2013). Another study performed a 10-week perceptual-motor intervention on Grade R learners in South Africa to determine the effect on academic achievement. A significant improvement was seen in the participants' visual perception and language scores (Erasmus et al. 2015).

There was a statistically significant improvement in the ESSI read results from pre- to post-test. As noted earlier, letter recognition is a key skill to be mastered when learning to read (Kersey & James, 2013). A focus of the current study was for the participants to recognize and identify different letters and shapes. Participants were required to pay attention to the direction and spatial orientation of letters individually and as part of a word. These activities were all combined with movement to create a multi-sensory experience.

Previous studies focusing on multi-sensory methods have shown to be beneficial because they allowed the participant to retain the visual image of the letter, as well as the movements necessary to produce it (Denton et al. 2006). Studies have also found that multi-sensory methods are very beneficial particularly for reading difficulties because it allows connections to be made between the word's sound and its visual appearance (Bara et al. 2007).

The ESSI spelling test results also indicated a statistically significant improvement in the experimental group from pre- to post-test. Spelling requires the child to accurately form letters and write them in the correct sequence. Letter formation is a cognitive process that requires well-developed perceptual motor skills (Bara & Gentaz, 2011). The perceptual component is related to the shape of the letter and the motor component relates to the movement producing the letter (Vinter & Chartrel, 2010). This involves being able to interpret visual symbols and

letters and being able to reproduce the sequence and direction of each line segment that the letter is made of (Dinehart, 2015; Julius et al. 2016).

Bara and Bonneton-Botte (2018), who performed a whole-body visuo-motor training programme on Grade R learners to determine the effect on letter knowledge, reported similar findings. The intervention performed by Bara and Bonneton-Botte (2018) involved children using their arms and the rest of their bodies to learn letters. Children were required to draw each letter in the air with their arm and walk along the outline of a letter on the ground. The main finding was that the gross motor movements of the letters had a positive impact on the children's letter formation and recognition. Their study also found that the gross motor intervention combined with visual motor skills improved the children's directionality (Bara & Bonneton-Botté, 2018).

Activities in the current study involved forming and tracing large letters through different ways. Through these activities, participants obtained perceptual information on the size, orientation and direction of the letter, as well as the gross motor movements that will be required to form this letter. By using different materials (e.g., ropes, chalk, sand and paper), to form and trace the letters, a multi-sensory experience was created. Furthermore, as supported by the embodied cognition theory, information obtained from learning accurate muscle control and coordination during the gross motor movements, allows the participant to better understand how to perform more abstract tasks, such as letter recognition and formation (McClelland et al. 2015).

Conclusions

The present study provides support for perceptual-motor interventions to improve children's academic skills. The study concluded that children's letter knowledge could be improved by implementation of an effective perceptual-motor programme. It can allow children to be active while learning, reducing sedentary time while upholding educational standards. Additionally, by including gross motor movements, it also improves the participants' fine motor skills such

as handwriting. Similar findings were concluded by Bara and Bonneton-Botte (2018). Furthermore, the study provides a new approach to perceptual-motor interventions; that movement can lead to enhanced academic achievement.

Study limitations include that assessments did not include assessing participants' letter-name knowledge (ability to name each letter individually) and technical letter formation skills such as stroke direction. Another study limitation includes that one class from each school formed the control groups and one class from each school formed the experimental groups due to practical reasons. There is also limited research on how gross motor and academic skills are related and how the one influences the other.

Further research should be done to assess children's technical letter formation skills that specifically relate to perceptual-motor skills. Research should also establish which specific gross motor skills relate to certain academic skills. Future interventions in this field should be developed in collaboration with teachers to allow for a more holistic approach to children's academics and physical activity and allow for a bigger sample size. It is also recommended that this study should be further developed to be implemented in various South African schools as part of the schools' reading and writing curriculum.

Declaration of conflicting interests

The author(s) declare no potential conflict of interest with respect to the research, authorship and/or publication of this article.

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Appendix 1

Table 1. Experimental and control group pre- to post-test Beery VMI

Beery VMI				
Group	Pre-test Mean ± SD	Post-test Mean ± SD	Pre- to post-test mean difference	Pre- to post-test P-value
Experimental	95,64 ± 10,21	111,38 ± 9,46	15,74	p=0.00000
Control	94,40 ± 10,56	93,45 ± 12,03	-0,95	

Table 2. Experimental and control group pre- to post-test ESSI reading results

ESSI Reading				
Group	Pre-test Mean ± SD	Post-test Mean ± SD	Pre- to post-test mean difference	Pre- to post-test P-value
Experimental	2,74 ± 1,29	5,49 ± 2,11	2,75	p=0.00000
Control	4,16 ± 2,25	4,39 ± 2,23	0,23	

Table 3. Experimental and control group pre- to post-test ESSI spelling results

ESSI Spelling				
Group	Pre-test Mean ± SD	Post-test Mean ± SD	Pre- to post-test mean difference	Pre- to post-test P-value
Experimental	3,48 ± 1,29	5,49 ± 2,11	2,01	p=0.00000
Control	3,88 ± 2,25	4,22 ± 2,23	0,34	

CHAPTER 5

RESEARCH ARTICLE 2
THE EFFECT OF A PERCEPTUAL-MOTOR INTERVENTION ON THE RELATIONSHIP BETWEEN MOTOR PROFICIENCY AND LETTER KNOWLEDGE.

Referencing and formatting within the chapter and the list of references at the end thereof has been done in accordance with the guidelines of the Developmental Science Journal (included in Appendix B). Consequently, the referencing and formatting style used in this chapter may differ from that used in the other chapters in this thesis. This article has been submitted for consideration in the Developmental Science Journal.

The effect of a perceptual-motor intervention on the relationship between motor proficiency and letter knowledge

Relationship between motor proficiency and letter knowledge

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CONFLICT OF INTEREST

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ABSTRACT

Movement is essential for learning. Previous research has explored the relationship between movement and academic performance, however, evidence regarding the specific gross motor skills related to reading and spelling is lacking. The current study, therefore, investigated the effect a perceptual-motor intervention had on the relationship between gross motor proficiency and letter knowledge in selected Grade 1 (6 to 7-year-old) children (N=97). Motor proficiency was measured using the BOT-2 and letter knowledge was assessed using the ESSI Reading and Spelling tests. The study found that a perceptual-motor intervention was effective in significantly improving both fine and gross motor proficiency skills, as well as reading and spelling ($p<0.01$). Results also revealed a positive correlation between overall motor proficiency and letter knowledge. Significant relationships were found between reading, spelling and the following gross motor skills ($p<0.01$): bilateral coordination, balance and upper-limb coordination. The main finding of the study showed that the strongest correlation was between motor proficiency and spelling ($r=0.46$). These results support a growing body of evidence suggesting that a child's gross motor development is essential for academic performance. Therefore, the integration of movement within academic tasks is an effective way in promoting both gross motor and learning abilities in Grade 1 children.

KEYWORDS

Grade 1, Gross motor skills, academic performance, perceptual-motor intervention, letter knowledge, motor proficiency.

RESEARCH HIGHLIGHTS:

- The perceptual-motor intervention, which consisted of gross motor movements, had positive effects on both fine and gross motor skills and letter knowledge.

- There is a positive association between reading, spelling and motor proficiency, with motor proficiency being correlated the strongest with spelling.
- The underlying gross motor skills related to improved reading and spelling include bilateral coordination, upper-limb coordination and balance.

1. INTRODUCTION

Sedentary behaviour in schools today has a negative impact on children's physical development and academic performance (O'Dwyer, Fairclough, Knowles & Stratton, 2012). A possible reason for the sedentary behaviour is the increasing demands on children's academic performance. This resulted in less time allocated for physical activity during the school day (Lu & Montague, 2016). However, physical activity is imperative for a child's development as it establishes a foundation for their cognitive, emotional and social development (Lopes, Santos, Pereira & Lopes, 2013; De Jager, 2014). Recent evidence suggests that movement and learning are interrelated processes and optimal physical and cognitive development is promoted when these processes are combined (Bartholomew & Jowers, 2011; Donnelly & Lambourne, 2011; Norris, Shelton, Dunsmuir, Duke-Williams & Stamatakis, 2015; Mullender-Wijnsma *et al*., 2016).

1.1. Learning through movement

Movement requires and provides the opportunity to transfer information between the two brain hemispheres. Therefore, in order to learn, children must move (Johnstone & Ramon, 2011). Every time movement occurs, sensory-motor stimulation is received, which assists children to interact with and understand their world. This forms the foundation for cognitive development (Fredericks, Kokot & Krof, 2006). This is supported by the theory of embodied cognition, which states that cognition is highly dependent on the body and that information is obtained through perception and action (McClelland, Pitt & Stein, 2015; Fugate, Macrine & Cipriano, 2018). Therefore, it could be assumed that the body itself is actively involved during learning and academic tasks, such as reading and spelling (Adolph & Franchak, 2017).

There are numerous reasons for the association between movement and learning. Research has shown that cognitive and motor processes develop at the same rate and developmental stages;

therefore, if a delay is caused in one area, the other will also be affected (Geertsen et al., 2016). Moreover, it is imperative for children to be proficient in their gross motor skills, as it is believed that gross motor proficiency foster academic abilities (Westendorp, Hartman, Houwen, Smith & Visscher, 2011). The muscles responsible for gross motor movements have a big influence on the muscles required for fine motor movements (Gligorovic, Radi & Ili, 2011). Therefore, only after a proper gross motor skills foundation is established will the development of fine motor skills, such as writing occur (Flatters et al., 2014; Bara & Bonneton-Botte, 2018). Furthermore, the brain utilises existing information obtained from sensory input, perceptual processing and motor control to be able to read and write. Therefore, it is believed that the brain can only develop intellectual capacity once the child has learned to control his or her physical actions and sensorimotor maps have been stored in the brain (McClelland et al., 2015). Another possible explanation for the link between movement and learning is that movement causes structural changes to the brain. Brain regions responsible for learning, such as the hippocampus are stimulated during physical activity (Oberer, Gashaj & Roebers, 2018). The cerebellum, prefrontal cortex (Geertsen et al., 2016), basal ganglia and their connecting structures are all co-activated during both motor and cognitive tasks (Carlson, Rowe & Curby, 2013; Oberer et al., 2018).

Previous studies have implemented mostly 'free-play' physical activity interventions and found a negative or a lack of associations between physical activity and certain cognitive aspects, such as working memory (Diamond & Ling, 2016; Cook et al., 2019). These studies suggest that the results are possible because of the nature of the physical activities being mostly free play and not being cognitively engaging enough. Therefore, more studies are needed to investigate the effect that a more structured, cognitively stimulating intervention will have on children's academic performance.

1.1.1. Motor proficiency

Children's movements start to become more refined and coordinated between the ages of 3 to 7 years. As they become more proficient in their movements, they are able to engage in more enhanced opportunities to explore and learn (Adolph & Franchak, 2017).

Increasingly, studies have been investigating the role of motor proficiency on children's academic achievement (Pienaar, Barhorst & Twisk, 2013; Ericsson & Karlsson, 2012; Da Silva Pacheco, Gabbard, Ries & Bobbio, 2016; Cadoret et al., 2018). Numerous studies have found positive associations between fine motor proficiency and academic achievement (Pitchford, Papini, Outhwaite & Gulliford, 2016; Bellocchi et al., 2017). However, there is a limited body of evidence that examined the relationship between gross motor proficiency and academic achievement. Pienaar et al. (2013) performed a cross-sectional study and found that gross motor proficiency and academic performance were strongly related in South African Grade 1 children. Lopes et al. (2013) conclude that children with a low gross motor proficiency have a higher probability to perform poorly in academic tasks. There is also limited research available on the specific components of gross motor proficiency related to academic achievement, specifically regarding reading and spelling. Bilateral coordination has been found to be an important motor proficiency skill for academic achievement because it provides neural stimulation to the brain and also coordinates the left and right side of the brain and body (Johnstone & Ramon, 2011). Postural strength is another aspect of motor proficiency that has been found to have a strong association with reading and spelling. The postural system provides stability to obtain perceptual information from the environment, which, in turn, is vital to guide coordinated movements of the hands and fingers (Flatters et al., 2014). More in depth research is needed with regard to identifying the underlying motor proficiency aspects related to reading and spelling.

1.1.2 Letter knowledge

Motor skills form a foundation for reading and spelling (McClelland & Cameron, 2019). An important feature for a child's literacy development is the acquisition of letter knowledge, which is comprised of two interacting skills known as letter recognition and -formation (James & Engelhardt, 2012; Kersey & James, 2013). Letter recognition requires the child to process and apply visual information such as the size, location, orientation and angles of the letter (Finkbeiner & Coltheart, 2009; Kersey & James, 2013). Handwriting, or letter formation, is a multifaceted skill, which requires a complex integration of cognitive, perceptual-motor and motor proficiency components. It involves an integrated pattern of coordinated movements, which depend on visual perception, as well as sensorimotor feedback (Capellini, Giaconi & Germano, 2017).

Both perceptual and motor components have to be stimulated to improve reading and spelling (Puranik, Lonigan & Kim, 2011). By adding a sensorimotor stimulation to reading and spelling, learning is enhanced (James & Engelhardt, 2012; Zemlock, Vinci-Booher & James, 2018). The sensory and motor systems are stimulated by physically interacting with the environment, thereby developing a clearer visual image and enhancing recognition performance (James, 2010).

1.2. Perceptual-motor integration

Perception forms the foundation for developing cognition and other motor skills (Adolph & Kretch, 2015). Perceptual-motor integration is the process of recognizing and interpreting sensory information obtained from the environment through one's senses and motor skills (Frost, Wortham & Reifel, 2012; Erasmus, Janse Van Rensburg, Pienaar & Ellis, 2015). Perceptual-motor skills can be classified into the following categories: spatial awareness; body awareness; directional awareness; temporal awareness; visual perception; and tactile

perception (Pienaar, Van Rensburg & Smit, 2011; Frost et al., 2012; Kersey & James, 2013; Elena, Georgeta, Cecila & Lupu, 2014).

1.2.1. Perceptual-motor skills

Numerous studies have stated that a child's perceptual-motor abilities is an important building block of cognitive development and is imperative for acquiring academic skills, such as reading and spelling (Gligorovic et al., 2011; Lobo, Harbourne, Dusing & Mccoy, 2013; De Waal, Pienaar & Coetzee, 2018). An important perceptual-motor skill for academic performance is body and spatial awareness. In order for children to move their limbs accurately and in a coordinated way, they have to have an internal sense of their body and its parts and how they move (Mehling et al., 2011). Another predictor of academic achievement is directional awareness (Richmond & Taylor, 2014). It includes components such as laterality, directionality, lateral preference and midline crossing (Pienaar, 2017). Laterality and directionality are important skills to develop for the correct orientation of letters, as well as for fluent reading (Richmond & Taylor, 2014). Failure to cross the midline will interfere with many of the child's academic tasks, such as reading fluently and sitting still while writing (Cheatum & Hammond, 2000).

1.2.2. Perceptual-motor interventions

What makes perceptual-motor interventions effective and unique is that it has proved to improve children's academic, as well as their motor skills (Pienaar et al., 2011; Hajezi, Aminian & Aminian, 2013; Sajedi & Berati, 2014; Erasmus, et al., 2015). Perceptual-motor interventions that aim to improve motor skills have produced significant results, proving that perceptual-motor skills are essential for overall motor development (Hajezi, et al., 2013; Sajedi & Berati, 2014). Sajedi and Berati (2014) found significant improvements in 4 to 6-year-old children's motor proficiency after an 8-week perceptual-motor intervention. Hajezi et al.

(2013) performed a 10-week perceptual-motor intervention and showed significant improvements in the participants' hand-eye coordination. Alternatively, other perceptual-motor interventions focused primarily on improving children's cognitive skills (Pienaar et al., 2011; Erasmus et al., 2015). These studies conclude that perceptual-motor interventions are beneficial for children's visual perception, language and other cognitive abilities, such as attention (Pienaar et al., 2011; Erasmus et al., 2015). Although there are sufficient evidence that perceptual-motor interventions are beneficial for academic achievement and motor proficiency, there is a lack of research investigating the effect a perceptual-motor intervention has on the relationship between these two variables. It is important to assess both motor and cognitive areas because these two areas are interdependent and rely on each other (Van der Fels et al., 2015). This will allow a better understanding of the specific components of motor proficiency and perceptual-motor skills that have an impact on a child's academic achievement.

An increasing number of studies have investigated the relationship between physical activity and academic performance (Da Silva Pacheco et al., 2016; Geertsen et al., 2016; Cadoret et al., 2018). Although positive associations were found, there is minimal research available regarding the relationship between gross motor proficiency, reading and spelling abilities. Investigating the link between motor proficiency and letter knowledge may provide clarity about the specific skills underlying a child's reading and writing abilities. Therefore, the current study aimed to investigate the effect of a perceptual-motor intervention on motor proficiency and letter knowledge, as well as the relationship between gross motor proficiency and letter knowledge in selected Grade 1 children.

2. METHODS

2.1. Research design

The current study, which can be defined as a triple-blinded study, used a quasi-experimental research design to test cause and effect relationships between variables. Quantitative data were collected before and after the intervention period from both the experimental and control groups.

2.2. Sample and participants

The study sample consisted of Grade 1 learners (N=100) between the ages of 6 to 7 years old in the Western Cape Province of South Africa. A convenience sample was used to select two schools from the Bellville (School A) and Stellenbosch (School B) areas because of their proximity and availability.

In each school, two classes were randomly selected to participate in the study. Random assignment was used to divide one class from each school into the control group (n=50) and the other class into the experimental group (n=50). School A consisted of a total 62 participants, with 30 learners in the experimental group and 32 in the control group. School B consisted of 38 learners, with 20 learners in the experimental group and 18 in the control group. After post-testing the final sample size was 97 (N=97) due to non-attendance.

2.3. Procedures

This study formed part of a larger study and data was collected by trained Kinderkinetics postgraduate students and qualified Kinderkinetici. Kinderkinetics is a profession that focus on the total well-being of children. Scientifically based and prescribed exercise programmes are used to promote the psychomotor, physical and neuro-motor development of children (Pienaar, 2009).

Pre-tests were administered during the first two weeks of the study, followed by a 12-week intervention and another two weeks of post-tests. All assessments took place at the participating schools during school hours in a quiet hall or classroom. Each participant was pre- and post-tested by the same evaluator to ensure validity.

The experimental group participated in the intervention twice a week for 12 weeks at the school, either in a hall or outside on a field during school hours. The intervention was planned by the main researcher and administered by Kinderkinetics postgraduate students, who were not involved in any of the assessments.

The current intervention was based on the Dynamic Systems Theory, which proposes that movement is produced from the interaction of multiple sub-systems within the individual, the task and the environment. When planning an intervention, it is important to consider these three systems and all aspects that affect them (Thelen, 1989). Regarding the current study, this theory suggests that academic skills, such as reading and spelling are not foundational skills because they are part of a complex interaction of different components (Cote, 2015). The current study also followed an integrated approach (top-down and bottom-up), to plan the intervention. The bottom-up approach aimed to improve children's underlying skills, which in turn improves a specific motor task (Kennedy, Brown & Stagnitti, 2013). The bottom-up approach, sensory-motor integration and perceptual-motor training was applied to focus on the child's senses through gross motor movements. The top-down task specific method was also integrated with the bottom-up approach to focus on the direct learning of the skill (letter recognition and -formation) (Auxter, Pyfer, Zittel & Roth, 2010).

The intervention focused primarily on perceptual-motor skills and incorporated letters into the activities. The focuses of the intervention were: body awareness; spatial awareness; temporal awareness; directionality; laterality; bilateral coordination; tactile stimulation; midline crossing; proprioception; and core strength. Directional awareness was included to develop the

ability to correctly orientate letters and to read more fluently (Richmond & Taylor, 2014). Moreover, the intervention incorporated different letters and shapes into gross motor activities with the aim to enhance letter recognition and -formation. Participants participated in gross motor activities while focusing on the correct direction and orientation of the letter.

Participants were divided into three groups in which they remained for the entire intervention period. Each group had a presenter that remained with them throughout each session for the duration of the intervention to ensure consistency. Every session consisted of a 7-minute proprioception stimulation exercise, followed by an 8-minute warm-up, four activities (each consisting of 10 minutes), and a 5-minute cool down. Proprioceptive stimulation was done before every session, which consisted of a deep pressure 'body map' massage to integrate information from various senses and to get the participants calm and focused for the session (De Jager & Victor, 2017).

2.4. Measurements

2.4.1. Motor Proficiency

The Bruininks-Oseretsky Test of Motor Proficiency-Second Edition (BOT-2), is a widely used standardised test for motor proficiency and is considered the gold standard for motor assessment (Davis, Pitchford & Limback, 2011; Da Silva Pacheco et al., 2016). This test tool provides a detailed assessment of both gross and fine motor proficiency (Bruininks & Bruininks, 2005). It was selected for its suitability to assess children's motor proficiency and because of its strong test-retest reliability (Cadoret et al., 2018).

The BOT-2 short form was used in the current study to obtain a single score of overall motor proficiency. The short form is an effective tool when the researcher wants to use the results as part of an evaluation tool and can be used as a screening tool to determine the need for further

assessment. It is fast and easy to adminster evaluation and provides an overall indication of the participants' motor proficiency (Bruininks & Bruininks, 2005).

The BOT-2 short form consists of 8 different subtests with 14 different items and several focuses for each item. The subtests are: Fine Motor (FM) Precision; FM Integration; Manual Dexterity; Bilateral Coordination; Balance; Running speed and Agility; Upper-limb Coordination; and Strength (Bruininks & Bruininks, 2005).

After administration of the BOT-2, the total motor composite is obtained. Standard scores are used to describe the participant's level of proficiency and relates the participant's performance to a representative sample of individuals of similar ages. The standard score is then used to obtain the descriptive category the participant scores in (Table 1). High internal consistency, test-retest and interrater reliability scores have been found with scores of 0.90, 0.80 and 0.97 respectively (Bruininks & Bruininks, 2005).

TABLE 4: BOT-2 descriptive categories

Descriptive Category	**Standard score range**
Well-above average	70 or greater
Above average	60-69
Average	41-59
Below average	31-40
Well-below average	30 or less

Note: Adapted from Bruininks & Bruininks (2005)

2.4.2. Letter knowledge

The ESSI Reading and Spelling tests are standardized South African reading and spelling tests available in English and Afrikaans. This evaluation consists of a vocabulary list, which is based on the South African school curriculum. The ESSI Reading and Spelling tests consist of a series

of 28 vocabulary words for Afrikaans and English-speaking learners in Grades 1 to 7. The tests are administered in the participant's home language (Afrikaans or English), and participants are required to read and spell these words within a specific timeframe (Esterhuyse, 2002).

After completion of the two tests, a score of 1 is allocated to a correct response and 0 for an incorrect response. Results are summated to determine the raw score, which is converted to a stanine score by using a norm table. Norms are calculated according to the individual's Grade, as well as the school term they are currently in. The stanine scale is a normalized standard scale, which provides a standard score ranging from 1 to 9, with a mean of 5 and a standard deviation of 1.96 (Esterhuyse, 2002). The ESSI Reading and Spelling tests have been found to have good reliability r=0.90 (Read) and r=0.85 (Spell), for Grade 1 learners. Content validity was ensured by involving experienced teachers in the identification of the words (Esterhuyse, 2002).

2.5. Ethics

Ethical clearance was obtained from the Research Ethical Committee of the University of Stellenbosch (REC-2018-7126), as well as the Western Cape Education Department (WCED). Permission was attained from each school principal and the teachers of the selected classes. Consent was given by the parents using a consent form explaining the details of the study as per the university's guidelines. Permission from the children was obtained by means of a verbal explanation of the study and a signed assent form. The current study adhered to the ethical concepts of respect for anonymity, confidentiality, beneficence, non-maleficence and autonomy.

2.6. Statistical analysis

Data was analysed by University's Centre for Statistical Consultation using the Statistica®, version 13.5.0.17 programme. Repeated measures ANOVA was applied to examine the effects

of the intervention on the outcome measurements. In this model, the participants were included as random effect and group (experimental or control), time (pre- or post-test) as fixed effects. The group*time interaction effect was calculated to determine whether the change over time was the same or different between the groups. Relevant means and standard deviations were reported and a 95% ($p<0.05$) confidence interval was used as guideline for significant results. Pearson correlations were used to investigate relationships of the ESSI Reading and Spelling variables with the BOT-2 variables. The following demonstrates the strength of the relationship for each absolute value of r (correlation) (Mukaka, 2012; Moore, Notz & Flinger, 2013): $r<0.3$ (none or very weak correlation); $0.3<r<0.5$ (weak correlation); $0.5<r<0.7$ (moderate correlation); and $r>0.7$ (strong correlation). Correlations with a p-value less than 0.05 ($p<0.05$) were considered statistically significant (Moore et al., 2013)

3. RESULTS

The total sample group (N=97) had a mean age of 7 years. The results report the mean, mean difference, standard deviations (SD), p-values and Pearson correlation coefficients for the BOT-2 and ESSI Reading and ESSI Spelling tests for both the experimental and control groups.

3.1. Motor proficiency

3.1.1. BOT-2 standard score

The standard score is an indication of the overall motor proficiency of the participants. There was a statistically significant[1] improvement in the experimental group's standard score from pre- to post-test ($p=0.00000$) with a mean difference of 9.62 (Figure 1). The control group showed minimal change with a pre-test score of 51.70 ± 8.75 and a post-test score of 50.39 ±

[1] Statistical significance is represented in the graphs using the letters 'a', 'b' and 'c'. Note that if the letters differ between the 2 groups (a and b/c), it is an indication that there is a statistically significant difference between the groups. If the letters differ from pre- to post-test within a group, it represents that the group has shown statistically significant improvement. However, if the letters remain the same between the groups or from pre-to post-test, no statistically significant results were found.

8.93. There was also a statistically significant difference between the experimental and control groups' scores after the post-test (p=0.00000). As can be seen in Figure 1, the control group scored higher than the experimental group during the pre-test, however, after the post-test, the experimental group showed larger improvement and scored higher (56.68 ± 9.54) than the control group (Table 2).

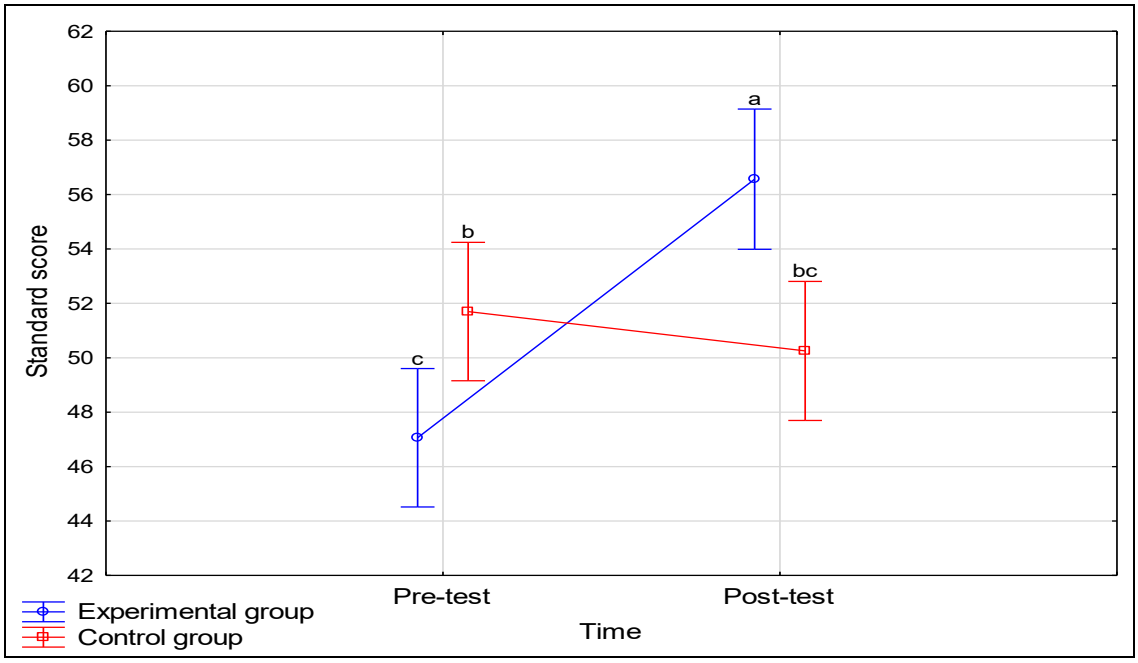

FIGURE 1: BOT-2 Standard score

3.1.2. BOT-2 subtests

As illustrated by Table 2, there was significant improvements in all the BOT-2 subtest scores of the experimental group (p<0.01). However, a statistically significant difference between the experimental and control groups was only observed in the Fine Motor integration and Fine Motor precision subtests (p<0.01).

TABLE 5: BOT-2 mean, SD and mean difference for experimental and control groups

	Experimental group			Control group			
	Pre-test Mean ± SD	**Post-test Mean ± SD**	**Mean difference**	**Pre-test Mean ± SD**	**Post-test Mean ± SD**	**Mean difference**	**p-value (Difference between groups)**
Standard score	47.06 ± 9.10	56.68 ± 9.54	9.62*	51.70 ± 8.75	50.39 ± 8.93	-1.31	p=0.00000
FM precision	9.30 ± 2.60	11.19 ± 2.36	1.89*	9.68 ± 2.80	9.90 ± 2.66	0.22	p=0.00120
FM integration	5.62 ± 2.25	7.89 ± 2.21	2.27*	6.28 ± 2.03	6.00 ± 2.25	-0.28	p=0.00000
Manual dexterity	3.56 ± 1.36	5.30 ± 1.90	1.74*	4.04 ± 1.24	4.90 ± 1.25	0.86*	p=0.00720
Upper limb coordination	8.74 ± 1.95	9.94 ± 1.96	1.20*	9.37 ± 2.26	10.00 ± 2.21	0.63**	p=0.24633
Bilateral coordination	6.38 ± 1.34	6.89 ± 0.37	0.51*	6.46 ± 1.37	6.65 ± 1.00	0.19	p=0.25071
Balance	7.24 ± 1.20	7.68 ± 0.75	0.44*	7.68 ± 0.74	7.57 ± 0.68	-0.11	p=0.01006
Running speed & agility	6.54 ± 2.10	7.62 ± 1.57	1.08*	7.90 ± 1.16	7.94 ± 0.73	0.04	p=0.00038
Strength	7.58 ± 2.58	8.83 ± 2.20	1.25*	8.22 ± 2.47	8.06 ± 2.11	-0.16	p=0.00414

Note: *p<0.01, **p<0.05

3.1.3. BOT-2 Descriptive categories

Figure 2 illustrates the change in the experimental group's performance in the BOT-2, from pre- to post-test. Before the intervention, 92% of the participants scored in the 'Average' and 'Below average' categories. After the intervention only 2% remained in the 'Below average' category, while 98% moved to the 'Average' and higher categories.

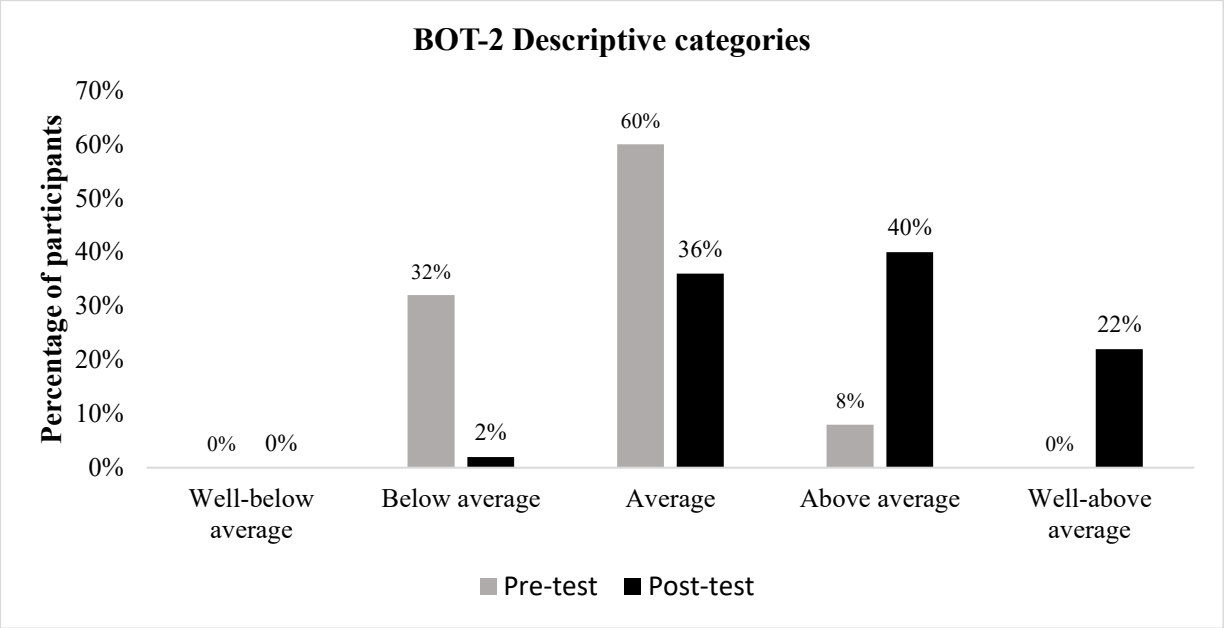

FIGURE 2: BOT-2 Descriptive categories for experimental group

3.2. Letter knowledge

In the current study letter knowledge is comprised of reading and spelling abilities and was measured by the ESSI Reading and Spelling tests.

3.2.1. ESSI Reading and ESSI Spelling tests

There was a significant improvement in the experimental group's ESSI Reading scores with a mean difference of 2.75, as well as a significant difference between the experimental and control groups' post-test scores ($p<0.05$) (Figure 3). The control group demonstrated minimal improvement with a mean difference of 0.23 from pre- to post-test.

In Figure 4, a significant difference can be observed between the experimental and control groups' ESSI Spelling scores ($p<0.05$). The experimental group also demonstrated significant improvement in their mean scores from pre- to post-test with a mean difference of 2.01, whereas the control group only showed slight improvement with a mean difference of 0.34.

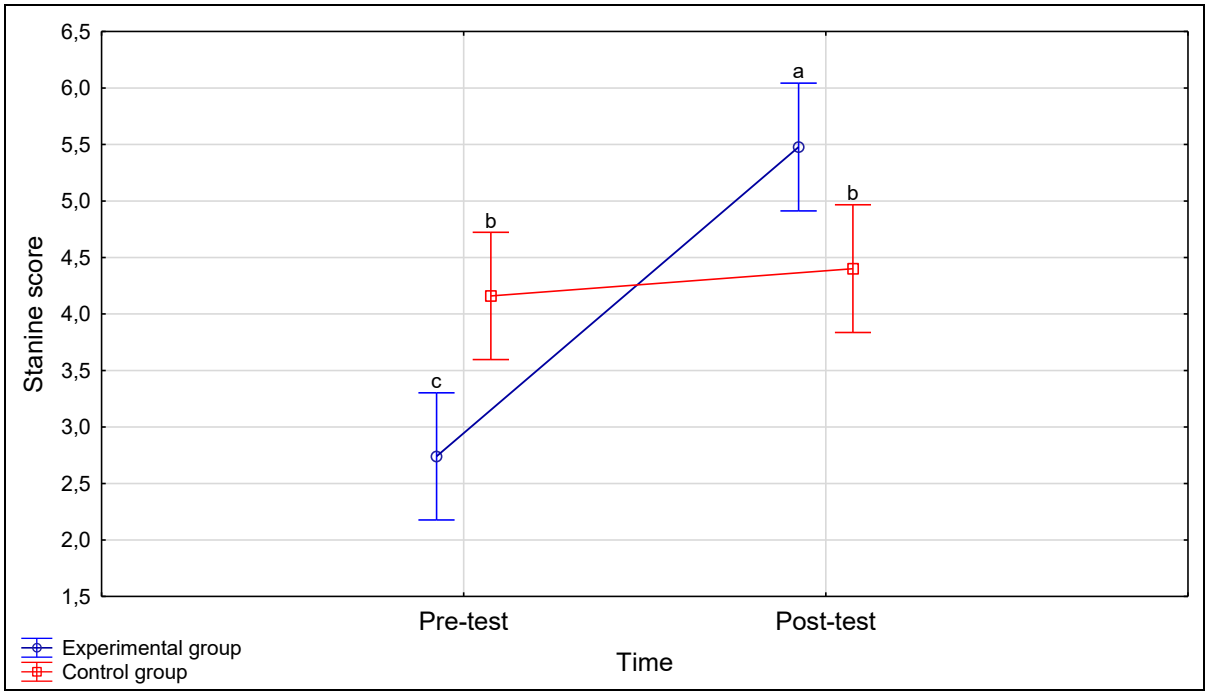

FIGURE 3: ESSI Reading test

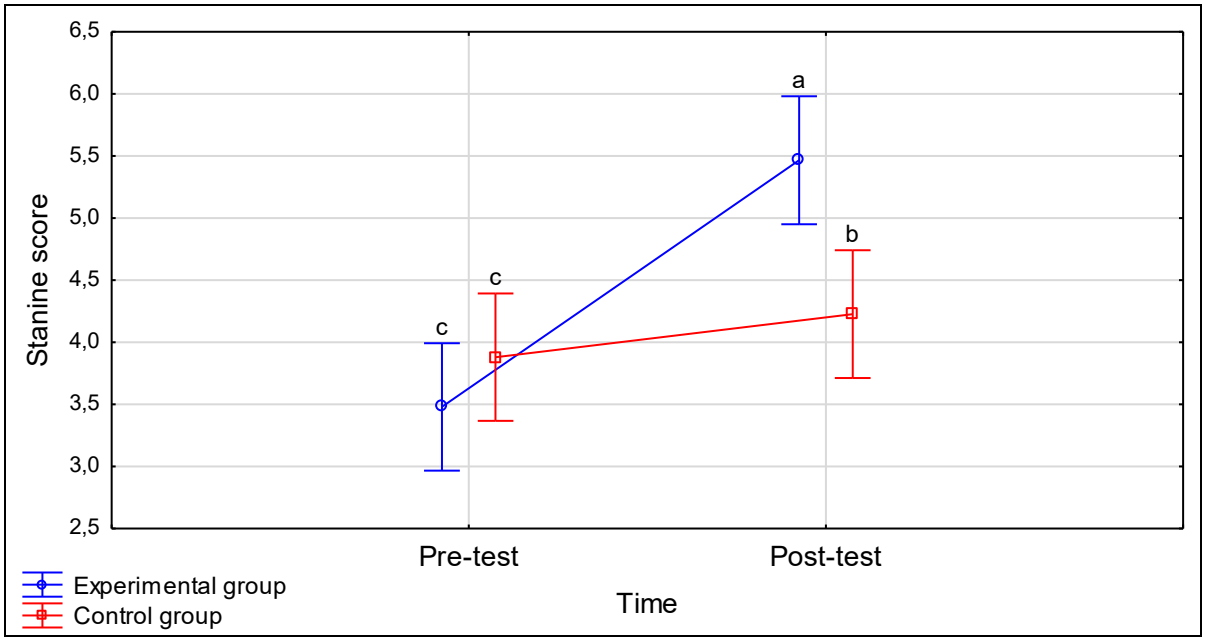

FIGURE 4: ESSI Spelling test

3.3. Motor proficiency and letter knowledge

Table 3 represents the Pearson-product correlation coefficients between the ESSI Reading and Spelling tests and the BOT-2 subtests and standard score. A positive correlation was observed between the ESSI Reading and Spelling tests and the following BOT-2 scores: standard score; FM precision and integration; manual dexterity; upper-limb coordination; bilateral coordination; and balance ($p<0.01$) (Table 3). The BOT-2 standard score showed a stronger correlation with the ESSI Spelling test (0.46) than with the ESSI Reading test (0.38). No significant correlation was observed between the ESSI Reading and Spelling tests and the BOT-2 running speed and agility and strength subtests ($p>0.01$).

TABLE 3: Pearson correlation results between ESSI Reading and Spelling and BOT-2

BOT-2	**Pearson correlation coefficients**	
	ESSI Read	**ESSI Spell**
Standard score	0.38*	0.46*
FM precision	0.27*	0.35*
FM integration	0.49*	0.52*
Manual dexterity	0.44*	0.47*
Upper-limb coordination	0.24*	0.31*
Bilateral coordination	0.18*	0.26*
Balance	0.20*	0.22*
Running speed & agility	0.07	0.05
Strength	0.14	0.20

***Note*: *=p<0.01**

4. DISCUSSION

The aim of this study was to investigate the effect a perceptual-motor intervention on motor proficiency, letter knowledge, as well as the relationship between motor proficiency and letter

knowledge in selected Grade 1 children. Overall, this study found positive correlations between certain components of motor proficiency and letter knowledge. Results of the study also found significant improvements in the experimental group's motor proficiency and overall letter knowledge after participation in a 12-week perceptual-motor intervention.

4.1. Motor proficiency

Significant improvements were found in the participants' overall motor proficiency scores after the post-test. It could be assumed that these improvements might have been because of participation in the perceptual-motor intervention. Some of the foci of the intervention were body awareness, laterality and midline crossing, which were incorporated through gross motor movements. These skills have been found to assist children in producing more accurate and coordinated movements (Mehling et al., 2011). Findings of this study are consistent with those of Sajedi and Barati (2014), who implemented an 8-week perceptual-motor intervention to determine the effect on 4 to 6-year-old children's fine and gross motor proficiency using the BOT-2. Similar to the current study, these researchers found significant improvements in the participants' overall motor proficiency scores (Sajedi & Barati, 2014).

Another significant finding of the study was the improvement observed in the experimental group's Fine Motor precision and Fine Motor integration scores. These results support the theory that fine motor movements are dependent on the development of gross motor movements (Gligorovic et al., 2011) because the current perceptual-motor intervention consisted of predominantly gross motor movements.

Although there were significant improvements seen in the experimental group's manual dexterity, upper-limb coordination, bilateral coordination, balance, strength, running speed and agility subtests, no significant differences were found between the experimental and control groups after the post-tests. The reason for this could be because the control group performed

better than the experimental group in the pre-test and, therefore, the experimental group began the intervention at lower scores. While the experimental group did score higher than the control group in all the subtests after post-tests, the difference between the groups was not big enough to show statistically significant difference.

4.2. Letter knowledge

The improvement in the participants' ESSI Reading and Spelling tests can also be speculated to because of participation in the perceptual-motor intervention. A similar study was done by Bara and Bonneton-Botte (2018), who implemented a whole-body visuo-motor intervention on pre-school learners to determine its effect on letter knowledge. The intervention incorporated activities involving the participants' whole bodies to learn letters through gross motor movements. The above-mentioned study measured letter knowledge by merely identifying and writing down individual letters. Similar to the current study, the whole-body intervention found significant improvements in the participants' letter knowledge. However, alternative to the current study, Bara and Bonneton-Botte (2018), did not evaluate whether the children's improved letter knowledge skills transferred to their reading and writing abilities. Another study implemented a 7-month gross motor intervention with the aim of improving 4 to 6-year-old children's perceptual-motor and cognitive skills. The intervention incorporated perceptual-motor and gross motor skills and the results indicated an improvement in the participants' school readiness, as well as cognitive and attentive skills (Pienaar et al., 2011). Although Pienaar and co-workers found significant improvements in the participants' cognitive abilities, they did not assess specific academic skills, such as reading and spelling. The current intervention focused on improving participants' reading and spelling abilities by improving their letter knowledge through perceptual-motor activities. This intervention can be assumed to have had an impact on the participants' ESSI Reading and Spelling scores because letter recognition is a key skill for reading and spelling accurately (Kersey & James, 2013).

Another possible factor that may have contributed to improved letter knowledge is the improvements in the participants' motor proficiency. It is well known that motor proficiency is strongly related to academic performance (Pienaar et al., 2013; Ericsson & Karlsson, 2012; Da Silva Pacheco et al., 2016; Cadoret et al., 2018). What is not clear is the underlying gross motor proficiency skills related to reading and spelling. The current study found significant improvements in the experimental group's bilateral coordination, balance, upper-limb coordination, speed, agility and strength scores. Although other studies have found that bilateral coordination has an impact on academic performance (McClelland et al., 2015; Da Silva Pacheco et al., 2016), few studies have investigated the effect it has specifically on reading and spelling. The current study's intervention incorporated bilateral coordination into activities to improve coordination of the opposite sides of the body (Johnstone & Ramon, 2011). These types of movements allow information to be transferred between the two brain hemispheres via the corpus callosum, which has an influence on reading. McClelland et al. (2015), indicate that repetitive bilateral coordination movements cause maturation of the corpus callosum. Therefore, based on these findings, it could be assumed that bilateral coordination improves reading.

Previous studies have also showed that strength and balance have an influence on academic abilities (Wittberg, Northupp & Cartrell, 2009; Du Toit, Pienaar & Truter, 2011). Strength develops a more stable base of support, which in turn allows for more control over goal-directed movements, such as writing. The current study's intervention incorporated numerous strength activities, specifically for the upper-body and core to provide the child with more stability (Adolph & Franchak, 2017), during seated academic tasks such as reading and writing. The improved upper-limb coordination may have also had an influence on participants' spelling scores. Upper-limb coordination requires the visual system to integrate information obtained

through the eyes and then use it to control and direct the hands to perform a desired task (Kaiser, Albaret & Doudlin, 2009).

Motor proficiency and letter knowledge

Results showed that there was a positive correlation between the BOT-2 standard score and the ESSI Reading and Spelling tests. These results are in agreement with the study of Cadoret et al. (2018), who demonstrated positive correlations between motor proficiency and academic achievement. Their study used the BOT-2 short form to measure motor proficiency and an academic measurement that included perceptual reasoning, working memory, reading, processing speed and mathematics. Their study further indicated a significant correlation of 0.28 ($p<0.01$), between reading and motor proficiency (Cadoret et al., 2018).

The current study found a stronger correlation between the ESSI Spelling test and overall motor proficiency compared to the ESSI Reading test. Few studies have investigated the relationship between spelling and motor proficiency (Da Silva Pacheco et al., 2016), as most have only looked at the relationship between reading and motor proficiency (Fernandes et al., 2016; Geersten et al., 2016; Cadoret et al., 2018). The strong association between spelling and motor proficiency can be explained by the strong associations between the fine motor proficiency subtests of the BOT-2 (Fine motor integration, Fine motor precision and manual dexterity) with spelling. Spelling involves letter formation, which requires fine motor coordination to be able to reproduce letters accurately (Rosenblum, 2015). Moreover, spelling also requires letter recognition and retrieving visual representations of that letter, which is more of a cognitive task involving memory. The gross motor movements involved in the current study could have contributed to the spelling performance of participants, because it is believed that movement activates memory (Geersten et al., 2016).

Significant positive correlations were also calculated between the following gross motor proficiency subtests and letter knowledge: upper-limb coordination; bilateral coordination; and balance. These findings support the theory that gross motor ability is strongly associated with academic performance (Westendrop et al., 2011). Cadoret et al. (2018) and Da Silva Pacheco et al. (2016) who investigated the relationship between gross motor ability and academic performance, found similar results. They indicated positive associations between the two variables and concluded that bilateral coordination had the highest impact on the participants' academic performance (Da Silva Pacheco et al., 2016).

The current study found no significant correlations between letter knowledge and strength and running speed and agility skills. These findings may be explained by the fact that these skills (strength and agility), require less of a cognitive demand to complete than other skills such as bilateral and upper-limb coordination (Fernandes et al., 2016). This theory is supported by the neuropsychological view stating that the relationship between motor and cognitive skills is dependent on the co-activation of the cerebellum and prefrontal cortex (Van der Fels et al., 2015). Similar to this study, Fernandes et al. (2016) found no significant relationship between agility and academic achievement. Da Silva Pacheco et al. (2016) argued that motor skills only have an influence on cognitive abilities and academic performance if they involve a form of motor specificity and are more cognitively engaging.

5. STRENGTHS AND LIMITATIONS

The nature of the perceptual-motor intervention was beneficial because it did not merely focus on gross motor skills, but was also cognitively engaging (Diamond & Ling, 2018; Cook et al., 2019). Another strength was the evaluation tools used in this study. Firstly, the ESSI Reading and Spelling tests were developed in the South African context and based on the South African curriculum and are thus appropriate for this population group (Esterhuyse, 2002). This contextual strength could also be a limitation of the study, because this test cannot be

generalized to other countries given that it uses South African norms. Another limitation of the research was the limited sample size, which was confined to certain areas in the Western Cape. This makes it hard to generalize the results to other areas in South Africa and other countries. Secondly, the use of the BOT-2 was also a strength of this study because it gives an overall score of children's motor proficiency. This is advantageous as results could be obtained on the participants' fine and gross motor proficiency and gives insight into which fine and gross motor proficiency skills are related to reading and spelling. Additionally, the BOT-2 is an internationally used tool, and therefore, allows for better comparison between countries (Bruininks & Bruininks, 2005). The current study also assessed whether letter knowledge transferred to the participant's specific academic abilities, namely reading and spelling. This is a strength because it is important to know whether the intervention will be beneficial in a real-world setting.

CONCLUSIONS AND CONTRIBUTIONS

The current intervention provides further support for perceptual-motor interventions with the aim of improving children's academic abilities and gross motor skills. The results of the study also gave an understanding into the gross motor factors underlying children's reading and spelling abilities. Findings indicated that gross motor proficiency contributes to the fine motor, as well as cognitive aspects of academic tasks. More specifically, these results uncovered the underlying gross motor proficiency skills related to reading and spelling, namely bilateral coordination, upper-limb coordination and balance. Although, the current study was conducted in the South African context, it also contributes to international research concerning the relationships between gross motor and academic skills in children. Unique to the current study was that the focus was not merely on cognition or letter recognition and formation, but also the transference of letter knowledge to reading and spelling abilities. This study also provided unique contributions to the relationship between motor proficiency and spelling, because

limited research has been done on this correlation. This highlights the need for future research on associations between gross motor and spelling abilities. Future interventions in this field should be developed with a more holistic approach, together with teachers and other practitioners. Further recommendations include a larger sample size and using the BOT-2 Complete form for a more comprehensive overview of the participants' motor proficiency. To conclude, this study emphasizes the need for schools to reconsider their approach to teaching, acknowledging that children need to move to learn.

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CHAPTER 6

CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

Referencing within this chapter and the list of references at the end thereof, have been done in accordance with the guidelines of the Department of Sport Science, Stellenbosch University.

INTRODUCTION

The current study outlined two sub aims and five objectives that were investigated thoroughly. The following sub aims were identified and investigated: 1) to determine the effect of a perceptual-motor intervention on letter knowledge (letter recognition and –formation); 2) to determine the relationship between motor proficiency and letter knowledge of selected Grade 1 children after participation in a perceptual-motor intervention.

The objectives that were investigated include: 1) to evaluate the participants' VMI and reading and spelling skills by using the Developmental Test of Visual-Motor Integration (Beery VMI) and the ESSI Reading and Spelling tests; 2) to examine the effectiveness of a perceptual-motor intervention by comparing results of the pre- and post-tests of the Beery VMI and ESSI Reading and Spelling tests; 3) to evaluate the participants' fine- and gross-motor proficiency using the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2); 4) to examine the effectiveness of a perceptual-motor intervention by comparing results of the pre- and post-tests of the BOT-2; 5) to examine the results of the BOT-2 in relation with the results of the ESSI Reading and Spelling tests.

After data collection and analysis and comparing the results of the current study with previous research, conclusions can be drawn. Recommendations and limitations are outlined and discussed. Limitations and recommendations are crucial for any study because it is provides a guideline for improving future research. These are outlined and discussed below

CONCLUSIONS

The conclusions drawn from this research were presented in accordance with the sub aims and objectives in Chapter Three.

Research Article 1: The effect of a perceptual-motor intervention on the letter knowledge of selected Grade 1 children.

Letter knowledge and Visual Motor Integration (Sub aim 1: objectives 1 & 2)

Letter recognition and -formation (letter knowledge) was measured by evaluating the participants' reading and spelling abilities using the ESSI Reading and Spelling tests. A major finding of the research was that pre-test results indicated that 67% of the

experimental group scored below average in the reading test and 46% scored below average in the spelling test. This shows that 67% of the children did not meet the average requirements for a Grade 1 child to read and 46% did not meet the average Grade 1 requirements for spelling. After the intervention significant improvements were found for both the ESSI Reading and ESSI Spelling tests in the experimental group. Post-test results indicated that only 25% of the experimental group scored below average, whereas 75% scored average and higher in the ESSI Reading test. In the ESSI Spelling test, only 17% scored below average and 83% scored average and higher. There were also significant differences found between the experimental and control groups after the post-test. The control group remained relatively stagnant from pre- to post-test in the reading and spelling test. VMI was measured using the Beery VMI. VMI is a key indicator of children's reading and writing performance. The significant improvements in the experimental group's VMI scores could, therefore, be a further indication of the improvements in their reading and spelling skills.

The significant improvements displayed by the experimental group in this study have important practical implications for the way in which children should learn to read and spell. The results indicate that a well-structured perceptual-motor intervention is a successful method to improve participants' reading and spelling. The study also provides a unique contribution to available research because it did not only assess children's letter recognition and -formation abilities, but whether improvement in these skills transferred to their reading and spelling performance.

Research Article 2: The effect of a perceptual-motor intervention on the relationship between motor proficiency and letter knowledge.

Motor proficiency (Sub aim 2: objectives 3 & 4)

Statistically significant improvements were observed in the experimental group's fine and gross motor proficiency after participation in the perceptual-motor intervention. The largest improvements were observed in the Fine Motor precision and Fine Motor integration items, which make up the Fine Manual control subtest. This is an important finding because it can be speculated that the intervention, which consisted of predominantly gross motor movements, was not only beneficial for gross motor development, but also for the fine motor skills of children. Results also indicated that 98% of participants reached the minimum motor proficiency level required for their age, whereas before the intervention, only 68% met these requirements. Furthermore,

statistically significant improvements were observed in the following gross motor subtests: bilateral coordination, upper-limb coordination, balance, running speed and agility, and strength. It could be assumed that these subtests had significant effects on the reading and spelling abilities of the participants and, therefore, can be classified as the underlying gross motor proficiency skills related to letter knowledge.

Motor proficiency and letter knowledge (Sub aim 2: objective 5)

The study provides unique contributions about the relationship between motor proficiency and letter knowledge. Positive correlations were observed between the two variables, with the strongest between motor proficiency and spelling. This indicates that motor proficiency is beneficial for the spelling skills of Grade 1 children. Limited studies have explored the relationships between motor proficiency and spelling, and therefore, this study provides evidence that more research should be conducted regarding this relationship. There were also positive correlations between the ESSI Reading and Spelling tests and the following BOT-2 subtests: FM precision and integration; manual dexterity; upper-limb coordination; bilateral coordination; and balance. This suggests that both fine and gross motor skills contribute to children's reading and spelling abilities.

LIMITATIONS

The following limitations are highlighted:

Participants and sample

- Convenience sampling was used because it allowed the researcher to choose a sample based on logistical and practical reasons. The current two schools were chosen because of their proximity and availability to participate for the full length of the study (16 weeks).
- The sample was confined to areas in the Western Cape; namely Stellenbosch and Bellville. This makes it difficult to generalise results to other areas in SA, as well as to other countries.

Assessments

- The ESSI Reading and Spelling tests were developed in the South African context, which was beneficial in the current study because it was appropriate for the population group. However, this limits the ability to generalize the results of the current study to other countries as it uses South African norms.
- Three participants did not attend any of the post-test assessments and, therefore, had to be excluded from the final results.

RECOMMENDATIONS

The following recommendations are presented for future research in this field:

Research

- Researchers in the field of early childhood development should consider determining the underlying aspects of children's academic development. The current study gave an insight into the underlying factors of reading and spelling, but it is recommended that future studies conduct more in-depth research concerning factors that can influence children's academic performance.
- Future studies in childhood development should also explore the individual learning preferences of children and determine the difference learning through movement will have on kinaesthetic, visual and/or auditory learners.
- It is further recommended that future child development studies assess the difference in the motor abilities and academic skills of children from different socioeconomic schools. This is to determine whether there are significant developmental differences in children from different socioeconomic environments.

Participants and sample

- Future studies researching children's motor and academic skills should be conducted with a bigger sample size and a wider range of areas in SA, that

includes various provinces as well as different socioeconomic schools. This is to determine whether the intervention will have similar effects and will also increase the generalizability of the research.

- Researchers in this field should also be investigate the effect of the intervention across different curriculums as the current study's schools followed the same curriculum.

Assessments

- A reading and spelling test that includes a bigger population and which is appropriate for a wider range of countries should be used.
- The BOT-2 complete form should be conducted in future studies because it provides a more in-depth and detailed indication of participants' motor proficiency skills.
- It is also recommended that future research should include a process-oriented assessment, which measures the quality of children's handwriting to obtain a more holistic indication of participants' literacy skills.
- Future studies should also determine the effects of a perceptual-motor intervention on children's overall academic performance, including assessments of their mathematics, attention and memory skills.

Intervention

- A longer intervention period will be even more beneficial for the children's development. It is recommended that future studies implement a longitudinal study of 1 year to determine whether children retain the skills obtained during the intervention. Furthermore, it is recommended that sessions be shorter (15 to 30 minutes) but occur every day of the week.
- A more holistic approach to the intervention should also be considered. Future research in child development should collaborate with teachers and occupational therapists to develop a programme that focuses on the whole child, including fine motor, sensory integration and educational skills.
- It is also strongly recommended that interventions focusing on movement and academics, such as the current study, should be permanently implemented in

schools in SA. As more demands are placed on children to perform academically and less focus is on their physical development, it is recommended that schools implement a combined approach, focusing on academics and movement simultaneously. Offering an integration of gross motor skills in the curriculum, may engage children more and enhance their overall development. It is recommended that these programmes occur every day for 15 to 30 minutes per day.

IMPLICATIONS

- The current study gives further support for research emphasizing the benefits of learning through movement for children. The Department of Education and schools should, therefore, reconsider their approach to planning and implementation of the curriculum. Adaptations should be made to allow for more movement during the school day as well as to train teachers to adopt a perceptual-motor or gross motor approach to their teaching methods.
- The study also provides evidence that children learn through movement. Therefore, Kinderkinetics can be beneficial for gross motor development to enhance academic achievement. Kinderkineticists in practice can, therefore, use perceptual-motor interventions, such as in the current study, to help neuro-typical children with motor and academic difficulties.

SUMMARY

The current study provides sufficient evidence that perceptual-motor interventions could be beneficial for Grade 1 children's reading and spelling performance. The results of the study indicate positive associations between children's fine and gross motor proficiency and reading and spelling abilities. The current intervention can provide Grade 1 children the opportunity to enhance their gross motor, fine motor and academic skills and ultimately increase their daily physical activity. It is recommended that more research be conducted in this field, assessing a wider variety of academic skills and that schools incorporate a movement programme into their curriculum.

APPENDICES

APPENDIX A

PERCEPTUAL AND MOTOR SKILLS JOURNAL

Manuscript submission guidelines: Perceptual and motor skills (SAGE publishing)

The purpose of Perceptual and Motor Skills is to encourage scientific originality and creativity in the fields of perception, learning and motor skills. Experimental or theoretical articles are welcomed. Perceptual and Motor Skills will assign manuscripts into three major sections, each with two subsections: Human Development (Biological/Environmental), Clinical Problems (Assessment/Intervention) and Peak Performance (Sports/Learning).

The guidelines below can also be found on the journal's submission site http://mc.manuscriptcentral.com/pms.

Article types

The Perceptual and Motor Skills journal accepts experimental and theoretical articles related with perception and/or motor skills.

Editorial policies

Peer review policy

The journal utilizes a double-blinded review process. Manuscripts submitted will be subject to external review by at least 2 reviewers. Critical editing and suggestions are provided to assist authors meet minimal standards of the journal

Authorship

All parties that contributed substantially to the article should be listed as authors. A student is usually listed as the principal author on publications derived from the student's dissertation or thesis.

Acknowledgements

Any contributors who did not meet the criteria for authorship should be listed in the acknowledgements section. This section should appear first at the end of your article prior to Declaration of conflicting interests and References.

Declaration of conflicting interests

It is the policy of the Perceptual and Motor Skills journal to include a declaration of conflicting interests from all authors. This section should be included at the end of the manuscript, after Acknowledgements and prior to the references. If no conflict exists, the author should state that 'The Author(s) declare(s) that there is no conflict of interest'.

Publishing policies

Plagiarism

Perceptual and Motor Skills and SAGE take issues of copyright infringement, plagiarism or other breaches of best practice in publication very seriously. Submitted articles may be checked with duplication-checking software. Where an article, for example, is found to have plagiarised other work or included third-party copyright material without permission or with insufficient acknowledgement, or where the authorship of the article is contested, we reserve the right to take action.

Contributor's publishing agreement

SAGE requires all authors to sign a Journal Contributor's Publishing Agreement. SAGE's Journal Contributor's Publishing Agreement is an exclusive licence agreement, which means that the author retains copyright in the work but grants SAGE the sole and exclusive right and licence to publish for the full legal term of copyright. Exceptions may exist where an assignment of copyright is required or preferred by a proprietor other than SAGE. In this case, copyright in the work will be assigned from the author to the society.

Open access and author archiving

Perceptual and Motor Skills offers optional open access publishing.

Permissions

Authors are responsible for obtaining permission from copyright holders for reproducing any illustrations, tables, figures or lengthy quotations previously published elsewhere.

Preparing the manuscript

Perceptual and Motor Skills conforms to the SAGE house style. Information on the SAGE house style can be found below or on: https://studysites.uk.sagepub.com/repository/binaries/pdf/SAGE_UK_style_guide_short.pdf

Note: Article 1 has been formatted according to the following guidelines. The margins, however, were set the same as the rest of the thesis.

Word processing formats

The text should be double-spaced throughout and with a minimum of 3cm for left- and right-hand margins and 5cm at head and foot. Text should be standard 10 or 12 point in Times New Roman font.

Main headings should have an initial capital with everything else lowercase, unless proper names. Second headings should be italic with initial cap, all the rest lowercase. Third heading should be the same as the second heading, but set as first line of paragraph, followed by a full stop.

Authors should be listed in the order that they appear on the manuscript. Authors' first name should be in full, middle names should be initials without full stops and no spaces between multiple initials. No series comma before the 'and' before the final author name.

Affiliations should contain only the following: department or faculty, institution, country. Titles, positions, qualifications, street names, or postcodes/zip codes should not be included. Affiliations should not end in a full stop.

Abstract should appear in bold without a colon; text should start on the next line, with no indent.

Keywords should appear in bold without a colon. The keywords should start on the next line, separated by commas only, not semi-colons. The first keyword should have an initial cap.

For figures, captions are positioned below the figures and left aligned. Captions should start, for example, **Figure 1.** (with a full point also in bold) and have a full point at the end. Where the text runs onto multiple lines, the captions need not be justified, but should be aligned left. Text citations: figures should be referenced in the text as follows: Figure 1, or Figures 1 and 2.

Tables do not need to be a full column width or page width but should be the appropriate width for the content. Table headings should be left aligned, even when they relate to multiple columns, unless this creates confusion. All tables should be numbered consecutively and cited in the text as Table 1, Table 2.

Reference style

Perceptual and Motor Skills adheres to the APA reference style. View the APA guidelines here: https://studysites.uk.sagepub.com/repository/binaries/pdf/APA_reference_style.pdf

Corresponding author contact details

Full contact details for the corresponding author including email, mailing address and telephone numbers should be provided. Academic affiliations are required for all co-authors. These details should be presented separately to the main text of the article to facilitate anonymous peer review.

Any correspondence, queries or additional requests for information on the manuscript submission process should be sent to the Perceptual and Motor Skills editorial office as follows:

J.D. Ball, Ph.D., ABPP

Eastern Virginia Medical School (ball@emeritus.evms.edu)

APPENDIX B

DEVELOPMENTAL SCIENCE JOURNAL

Manuscript guidelines: Developmental Science

Developmental Science aims to represent the very best of contemporary scientific developmental psychology and developmental cognitive neuroscience, both in the presentation of theory and in reporting new data. Developmental Science includes: comparative and biological perspectives, connectionist and computational perspectives, and developmental disorders. Developmental Science publishes work that bridges levels of explanation, such as from brain development to cognitive or social change, or work that specifically attempts to elucidate mechanisms of developmental change at one level. All papers published in Developmental Science are eligible for Panel A: Psychology, Psychiatry and Neuroscience in the Research Excellence Framework. All manuscripts will initially be assessed rapidly for relevance to the aims of the journal, breadth of interest and potential impact. Developmental Science looks for submissions that will have general significance for a broad spectrum of developmentalists, reporting findings that can be considered as more breakthrough than incremental, with a focus on mechanism, and with a developmental theme.

Note: Article 2 has been formatted according to the following guidelines. The margins, however, were set the same as the rest of the thesis.

Word limit: 8000 words
Font: Times New Roman 12, double spaced, justified
Headings:

- Heading 1: All Caps, bold with section number
- Headings 2 and 3: Sentence case, bold with section number
- Heading 4: Sentence case, italic without section number
- Heading 5: Sentence case, italic, without section number, run-on title.

Title page

The title page should contain:

- A short informative title that contains the major key words. The title should not contain abbreviations;

- A short running title of less than 40 characters;
- The full names of the authors;
- The authors' institutional affiliations at which the work was carried out;
- Conflict of Interest Statement;
- Acknowledgements.

The present address of any author, if different from that where the work was carried out, should be supplied in a footnote.

Acknowledgements

Contributions from anyone who does not meet the criteria for authorship should be listed, with permission from the contributor, in an Acknowledgments section. Financial and material support should also be mentioned.

Conflict of Interest Statement

Authors should provide a conflict of interest statement during the submission process.

Main Text File

Papers are double-blind peer reviewed.

The main text file should be presented in the following order:

- Title;
- Research highlights;
- Abstract and key words;
- Main;
- References;
- Figures and tables (each clearly identified, labelled and on a separate page);
- Appendices (if relevant).

Supporting information (if any) should be supplied as separate files.

Research Highlights

Authors are required to submit up to four 'Research Highlights' with their manuscripts. These are bulleted points outlining the key contributions to research the paper makes. The Research Highlights should be placed before the abstract. Each research highlight should not be longer than 25 words.

Abstract

Abstracts should be in the form of a continuous narrative, rather than divided into distinct sections (i.e., Background, Methods, Results, Conclusions). An abstract of no more than 250 words, containing the major keywords should be provided.

Keywords: Six keywords should be provided.

References

References should be prepared according to the *Publication Manual of the American Psychological Association* (6th edition). This means in text citations should follow the author-date method whereby the author's last name and the year of publication for the source should appear in the text. The complete reference list should appear alphabetically by name at the end of the paper. Please note that a DOI should be provided for all references where available. Please note that for journal articles, issue numbers are not included unless each issue in the volume begins with page one.

Tables

Tables should be self-contained and complement, not duplicate, information contained in the text. All abbreviations must be defined in footnotes.

Ensure tables are referenced within the text. Include any tables either at the end of the manuscript or as separate files, not throughout the text.

Figures

Ensure figures are referenced within the text. Include any figures either at the end of the manuscript or as separate files, not throughout the text.

More information on the Wiley House Style guidelines can be found at https://authorservices.wiley.com/asset/photos/House_style_guide_ROW4520101451415.pdf

Editorial office contact details:

Thomas Gaston, Managing Editor

Bernadith Millamina, Editorial Assistant

E-mail: devsciedoffice@wiley.com

APPENDIX C

CONSENT FORM

STELLENBOSCH UNIVERSITY

CONSENT TO PARTICIPATE IN RESEARCH

Parent/Legal guardian

THE EFFECT OF A PERCEPTUAL-MOTOR INTERVENTION ON THE MOTOR PROFICIENCY, LETTER RECOGNITION AND -FORMATION OF SELECTED GRADE 1 CHILDREN.

You are kindly requested to consent that your child may participate in a research study conducted by Sharnay Botha and her team from the Department of Sport Science at Stellenbosch University. All results will contribute to the research article. Your child has been identified as a possible participant in this study because he/she attends one of the selected schools in this research project.

1. **PURPOSE OF THIS STUDY**

To explore the impact of a perceptual-motor intervention on the academic performance of Grade 1 children. The study will specifically focus on letter recognition and letter formation skills.

2. **PROCEDURES**

If you consent that your child may participate in this study, we would ask him/her to do the following things. Firstly, your child will undergo a pre- assessment, which consists of activities that assess motor proficiency and reading and writing skills. This will take place at your child's school and will be conducted by qualified Kinderkineticists, as well as Kinderkinetics Honours students. The pre-assessment will occur during July and August 2018 and each assessment will take approximately 30 minutes to complete per child. The child's mood and ability will also determine how long the assessment might take. After the pre-assessment, the researchers will use the results to develop a specific 12-week programme for the participating children. The programme will be conducted at your child's school. At the end of the 12 weeks, post-assessment will occur to determine the impact of the perceptual-motor intervention programme.

3. POTENTIAL RISKS AND DISCOMFORTS

There are not any serious risks involved in this study. Your child may perspire because of participation in physical activities, but he/she is at no more risk than with everyday playing. There is also a potential risk of falling during any of the activities; however, if this might happen your child will be properly attended to. Supervisors will be present at all times and all the Kinderkineticists and Kinderkinetics Honours students involved in the program are qualified in First Aid.

4. POTENTIAL BENEFITS TO SUBJECTS AND/OR SOCIETY

The main focus of the study is to improve the academic performance of your child, specifically reading and writing. The program will also be used at other schools in the future as a means to improve academic performance through physical activity.

5. PAYMENT FOR PARTICIPATION.

No payment will be made for participation in this study.

6. CONFIDENTIALITY

Any information that is obtained in connection with this study and that can identify you or your will remain confidential and will be disclosed only with your permission or as required by law. Confidentiality will be maintained by means of a secure laptop that only the main researcher will have the password for. Additionally, a password protector will be placed on the main file to ensure the file is secure. Even though other Kinderkinetics Honours students will be assisting with the collection of data, all results will only be handled and be accessed by the main researcher. All hardcopies of test results will be placed in a locked cupboard, which only the main researcher will have a key for.

7. PARTICIPATION AND WITHDRAWAL

It will be verbally explained to your child that he/she can choose whether to be in this study or not. If your child volunteers to participate in this study, he/she may withdraw at any time without any consequences of any kind. He/she may also refuse to answer any questions they do not want to answer and still remain in the study. The researcher may also withdraw your child from this study if circumstances arise which warrant doing so.

8. IDENTIFICATION OF INVESTIGATORS

If you have any questions or concerns about the research, please feel free to contact Sharnay Botha at 0760220723 or at sharnaybotha2@gmail.com.

9. RIGHTS OF RESEARCH SUBJECTS

Your child may withdraw their consent at any time and discontinue participation without penalty. Neither you nor your child are 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 participant, you can contact Ms Maléne Fouché [mfouche@sun.ac.za; 021 808 4622] at the Division for Research Development.

DECLARATION OF CONSENT BY THE PARENT/ LEGAL GUARDIAN OF THE CHILD- PARTICIPANT

As the parent/legal guardian of the child, I confirm that:

- I have read the above information and it is written in a language that I am comfortable with.
- All issues related to privacy and the confidentiality and use of the information have been explained to me in the document.

By signing below, I _____ *(parent/legal guardian name)* agree that the researcher may approach _____ *(child's name)* to take part in this research study, as conducted by Sharnay Botha.

_____ _____

Signature of Parent/Legal Guardian **Date**

DECLARATION BY THE PRINCIPAL INVESTIGATOR

As the **principal investigator,** I hereby declare that the information contained in this document has been explained to the parent/legal guardian. I also declare that the parent/legal guardian was given ample time to ask any questions.

_____ _____

Signature of Principal Investigator **Date**

APPENDIX D

TOESTEMMINGSVORM

UNIVERSITEIT STELLENBOSCH UNIVERSITY

STELLENBOSCH UNIVERSITEIT

TOESTEMMINGSVORM

Ouer/Wettige voog

Die effek van ’n perseptueel- motoriese intervensie op die motoriese vaardighede, letter erkenning en -formasie van Graad 1 leerlinge.

U word vriendelik versoek om toestemming te gee dat u kind aan ’n navorsingstudie, uitgevoer deur Sharnay Botha en haar span van die Departement van Sportwetenskap, Universiteit Stellenbosch, mag deelneem. Alle resultate sal ‘n bydra tot ’n navorsing artikel maak. U kind is gekies as ’n moontlike deelnemer in hierdie studie omdat hy/sy ‘n leerder van een van die verkose skole in die navorsingsprojek bywoon.

1. **DOEL VAN DIE STUDIE**

Die doel van die studie is om die effek van ’n perseptueel-motoriese intervensie program op die akademiese prestasie van Graad 1 leerlinge te ondersoek. Die studie sal spesifiek op die leerders se letter erkenning en -formasie vaardighede fokus.

2. **PROSEDURES**

Indien u toestemming verleen dat u kind vrywillig aan hierdie studie mag deelneem sal die volgende plaasvind Eerstens, sal u kind pre-assessering ondergaan. Dit behels aktiwiteite wat motoriese vaardigheid, asook lees- en skryf vaardighede assesseer. Dit sal plaasvind by u kind se skool en sal deur gekwalifiseerde Kinderkinetikiste en Kinderkinetika Honneursstudente uitgevoer word. Die pre-assessering sal in Julie en Augustus 2018 plaasvind en sal ongeveer 30 minute duur. Daarna sal die navorsers die resultate gebruik om ’n 12-week perseptueel-motoriese vir die deelnemers uit te werk. Die intervensie program sal by u kind se skool aangebied word. Na die 12-week program sal post-assessering plaasvind om die impak van die program te bepaal.

3. POTENSIËLE RISIKO'S EN ONGEMAK

Daar is geen risiko's verbonde aan die studie nie. Daar is 'n moontlikheid dat kinders tydens die aktiwiteite mag val. Indien dit sou gebeur sal u kind behoorlik versorg word. Toesighouers sal teen alle tye betrokke wees en al die Kinderkinetici en Kinderkinetika Honneursstudente betrokke in die program is gekwalifiseerd in Noodhulp.

4. POTENSIËLE VOORDELE VIR LEERDERS EN DIE SAMELEWING

Die hoof fokus van die studie is om die akademiese prestasie van u kind te verbeter, meer spesifiek lees- en skryf vaardighede. Die program sal ook by ander skole in die toekoms gebruik word om akademiese prestasie deur fisieke aktiwiteite te verbeter

5. BETALING VIR DEELNAME

Geen betaling sal aan deelnemers van die studie gedoen word nie.

6. VERTROULIKHEID

Alle inligting wat in verband met die studie verkry word sal vertroulik bly en sal net met toestemming bekend gemaak word. Vertroulikheid sal gehandhaaf word deur middel van 'n wagwoord beskermde rekenaar sodat slegs die hoofnavorser toegang daartoe sal hê. Die hoof dokument met al die inligting en data sal ook met 'n wagwoord beskerm word. Alle data sal net deur die hoofnavorser en studieleier hanteer word. Alle harde kopieë van die resultate sal in 'n kluis bewaar word.

7. DEELNAME EN ONTTREKKING

Dit sal aan u kind verduidelik word dat hy/sy self kan besluit of hy/sy wil deel wees van die studie. As u kind vrywillig instem om deel te neem aan die studie, mag hy/sy op enige tyd besluit om hom/haar aan die studie te onttrek sonder enige gevolge. Indien u kind onttrek, sal sy/haar data wat ingesamel was, nie gebruik word nie en sy/haar sal vernietig word. Hy/sy mag weier om enige vrae te beantwoord en nog steeds aan die studie deelneem. Die navorser mag ook u kind onttrek van die studie indien sekere omstandighede dit vereis.

8. IDENTITEIT VAN NAVORSERS

As u enige vrae of bekommernisse het oor die navorsing, kontak gerus vir Sharnay Botha op 076 0220 723 of op epos: sharnaybotha2@gmail.com.

9. REGTE VAN DEELNEMERS

U kind mag enige tyd aan die studie onttrek en deelname staak sonder enige gevolge. Nie u of u kind doen afstand van enige regseise as gevolg van deelname in die navorsing projek nie. As u enige vrae rondom u regte in verband met die navorsing

projek het, kontak Mev. Maléne Fouché [mfouche@sun.ac.za; 021 808 4622] by die Departement Navorsingsontwikkeling.

VERKLARING VAN TOESTEMMING DEUR DIE OUER/WETTIGE VOOG VAN DIE KIND

As ouer/wettige voog van die kind, bevestig ek die volgende:

- Ek het deeglik deur die bogenoemde inligting gelees wat in ‘n taal geskryf is waarmee ek vertroud is.
- Alle kwessies in verband met privaatheid die vertroulikheid en gebruik van inligting is vir my in die dokument verduidelik.

Deur hieronder te teken, stem ek _____ *(ouer/wettige voog)* saam dat die navorser _____ *(kind se naam)* mag nader om deel te neem in die navorsingsprojek, uitgevoer deur Sharnay Botha.

_____ _____

Handtekening van Ouer/Wettige Voog **Datum**

VERKLARING VAN HOOF NAVORSER

As die hoofnavorser, verklaar ek hiermee dat die inligting oor die navorsingsprojek in die dokument verduidelik is. Ek verklaar ook dat die ouer/wettige voog genoeg tyd gehad het om enige vrae te vra.

_____ _____

Handtekening van Hoof Navorser **Datum**

APPENDIX E

ASSENT FORM

STELLENBOSCH UNIVERSITY

PARTICIPANT INFORMATION LEAFLET AND ASSENT FORM

TITLE OF THE RESEARCH PROJECT: The effect of a perceptual-motor intervention on the motor proficiency, letter recognition and -formation of selected Grade 1 children.

RESEARCHERS NAME: Sharnay Botha & Dr Eileen Africa.

ADDRESS: Department of Sport Science, Stellenbosch University.

CONTACT NUMBER: 076 0220 723

What is research?

Research is something we do when we want to find out something new and understand how certain things work. We use research to learn more about children and to help them.

What is a Kinderkineticist?

A kinderkineticist is someone who loves to work and play with children. We want to help you learn new fun skills while we play fun games.

What is this research project all about?

This research project is all about the fun of learning. We are going to do some fun and exciting games and exercises to help you with reading and writing.

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

You have been chosen because you are special and I would like to help you learn in a more fun way. This research project can help you become better at reading and writing and help you enjoy it.

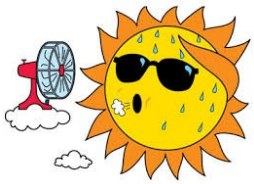
Who is doing the research?

Dr E. Africa, Sharnay Botha and her Kinderkinetics team is doing the research. Everyone that will be doing research loves working with children and wants to help you.

What will happen to me in this study?

We will come on Tuesdays and Thursdays to your school for 30 minutes. You will then take part in fun and exciting activities for 3 months. Before any activity, I, or one of the other Kinderkineticists, will show you exactly what you must do. We will play outside and learn about different letters and shapes and learn how to use the two sides of our bodies separately.

Can anything bad happen to me?



No, nothing can hurt you.

It might get a bit hot, but when it is too hot, we will take lots of water breaks and rest for a while.

Can anything good happen to me

Yes, that is why we are doing this research project. It can help you learn how to move your body better, learn how to read and write more easily and help you feel more confident.

Will anyone know I am in the study?

No one will know that you took part in the study. We keep all the names top secret and all the information will be safely locked away.

Who can I talk to about this study?

You can contact Sharnay Botha on 076 0220 723 if you have any questions or comments about the study.

What if I do not want to do this?

It is entirely your decision to take part in the study or not. If you do not want to be part of the study, nothing bad will happen to you. You can stop at any time you do not feel comfortable taking part anymore and go back to class.

Do you understand this research study and are you willing to take part in it?

 ☐  ☐

Has the researcher answered all your questions?

 ☐  ☐

Do you understand that you can pull out of the study at any time?

 ☐  ☐

_____ _____

Signature of child Date

APPENDIX F

INWILLIGINGSVORM

STELLENBOSCH UNIVERSITY

DEELNEMER INFORMASIE EN INWILLIGINGSSVORM

TITEL VAN DIE NAVORSINGSPROJEK: Die effek van 'n perseptueel-motoriese intervensie op die motoriese vaardighede, letter erkenning en -formasie van Graad 1 leerders.

NAVORSERS: Sharnay Botha & Dr Eileen Africa.

ADRES: Departement Sportwetenskap, Stellenbosch Universiteit.

KONTAK NOMMER: 076 0220 723

Wat is navorsing?

Navorsing is iets wat ons doen wanneer ons iets nuuts wil uitvind en om te verstaan hoe sekere goed werk. Ons gebruik navorsing om meer te leer van kinders en hoe om hulle te help.

Wat is 'n Kinderkinetikus?

'n Kinderkinetikus is iemand wat baie daarvan hou om met kinders te werk en speel. Ons wil julle graag help om nuwe vaardighede te leer terwyl ons lekker speel.

Waaroor gaan die navorsingsprojek?

Die navorsing projek gaan oor hoe om lekker te speel terwyl mens leer. Ons gaan paar lekker speletjies en oefeninge saam doen om jou te help lees en skryf.

Hoekom is ek gevra om deel te neem in die navorsing taak?

Jy is gekies omdat jy is spesiaal en ons wil jou help om te leer terwyl jy speel. Die navorsingstaak kan jou help beter te lees en skryf.

Wie gaan die navorsing doen?

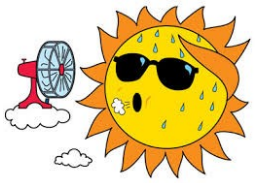
Dr E. Africa en haar Kinderkinetika span gaan die navorsing doen. Almal wat navorsing gaan doen is baie lief daarvoor om met kinders te werk en speel en wil jou graag help.

Wat gaan met my gebeur in die studie?

Ons gaan twee dae ’n week na jou skool toe kom vir 45 minute. Jy kan dan deelneem aan lekker speletjies vir 3 maande. Voor enige aktiwiteit gaan ek of een van die ander Kinderkinetici vir jou wys wat ons gaan doen. Ons gaan buite speel en dan meer leer oor verskillende letters en vorms en ook leer hoe om die verskillende dele van ons liggaam saam te gebruik.

Kan enige iets slegs met my gebeur?

Nee, niks slegs kan met jou gebeur nie. Dit kan dalk bietjie warm raak, maar ons sal ’n water breek neem en vir ’n tydjie rus .



Kan iets goeds met my gebeur?

Ja, dit is hoekom ons die projek doen. Dit kan jou help om te leer hoe om jou liggaam beter te gebruik en hoe om te lees en skryf.

Sal enige iemand weet ek is in die studie?

Nee, niemand sal weet jy het deel geneem nie. Ons hou almal se name 'top secret' en al jou informasie sal veilig toegesluit word.

Met wie kan ek praat oor die studie?

Jy kan my kontak, Sharnay Botha op 076 0220 723 as jy enige vrae oor die studie het.

Wat as ek nie dit wil doen nie?

Dit is heeltemal jou eie besluit of jy wil deelneem of nie. As jy nie deel wil wees nie, sal niks slegs met jou gebeur nie. Jy kan stop net wanneer jy wil.

Verstaan jy waaroor die navorsingsprojek gaan?

 ☐  ☐

Het die navorser al jou vrae beantwoord ?

 ☐  ☐

Verstaan jy dat jy enige tyd kan besluit om nie meer deel te wees van die studie nie?

 ☐  ☐

_____ _____

Handtekening van kind Datum

APPENDIX G

BOT-2 SUBTEST DESCRIPTION

Subtest 1: Fine motor precision

Drawing lines through crooked path

- *Procedure*: Child will sit at a desk. Place the page with the path in front of child with a pencil. Child can use dominant hand to hold pencil and draw a line through the path, from the car to the house. Explain to child that he or she is allowed to stop and restart.
- *Aim***:** Child should not go outside the boundary line.
- *Trial:* One trial.
- *Time:* No time limit.

Folding paper

- *Procedure:* Child will sit at a desk. Place the folding paper in front of child. Demonstrate folding the one corner of the page on the indicated line. Child should fold the remaining three corners and then fold the paper in half along the middle line.
- *Aim:* Fold each corner on the indicated line.
- *Trial:* One trial.
- *Time:* No time limit.

Subtest 2: Fine motor integration

Copying a square and star

- *Procedure:* Child will sit at a desk. Place the shape page in front of child. Explain to child that he or she should copy each shape in the empty box below the shape. Attention should be given to the overall size, basic shape, closure, edges and orientation of the shape.
- *Aim:* Copy each shape exactly as it is in the empty box.
- *Trial:* One trial.
- *Time:* No time limit.

Subtest 3: Manual dexterity

Transferring pennies

- *Procedure:* Child will sit at a desk. Place penny pad in front of child with 20 pennies on the dominant hand's side and the box on the other side. When examiner instructs child to start, the child has to pick up one penny at a time, transfer it to the other hand and then into the box. Continue until examiner stops him or her.
- *Aim:* Transfer as many pennies as possible into the box in the allocated time without dropping them.
- *Trial:* Two trials.
- *Time:* 15 seconds per trial.

Subtest 4: Bilateral coordination

Jumping in place-same sides synchronized

- *Procedure:* Child stand with dominant leg and arm on the same side forward, and the other arm and leg to the back. Child then has to jump and change sides, bringing non-dominant arm and leg forward, and moving the other arm and leg to the back. Continue to jump, alternating leg and arm positions with each jump.
- *Aim:* Jump changing sides 5 times in a continuous motion (no pauses).
- *Trial:* Two trials, except if child completed 5 correct jumps on first trial.
- *Time:* No time limit.

Tapping feet and fingers-same sides synchronized

- *Procedure:* Child will sit at a desk with index fingers extended and placed on the table. The child has to simultaneously tap his or her foot or finger on the same side, and then repeat with the other side. Continue tapping, alternating between the left and right sides until examiner stops child.
- *Aim:* Tap feet and fingers with continuous movements for 10 consecutive taps.
- *Trial:* Two trials, except if child successfully completed 10 taps on first trial.
- *Time:* No time limit.

Subtest 5: Balance

Walking forward on a line

- *Procedure:* Place down a straight line of masking tape. Child will stand with feet together at the start of the line with preferred foot on an parallel to the line. Child has to place hands on hips and walk forward in a natural walking stride, placing feet on and parallel to the line.
- *Aim:* Walk forward on the line for 6 consecutive steps without stepping off the line.
- *Trial*: Two trials, except if child successfully completed 6 consecutive steps on the line during the first trial.
- *Time:* No time limit.

Standing on one leg on a balance beam-eyes open

- *Procedure:* Child will stand on the balance beam with preferred foot and hands on hips. Non-preferred leg has to be raised behind child, with knee bent 90-degrees and shin parallel to the floor.
- *Aim:* Balance on preferred foot for 10 seconds without dropping non-preferred leg.
- *Trial:* Two trials, except if child balanced for 10 seconds on first trial.
- *Time:* 10 seconds per trial.

Subtest 6: Running speed and agility

One leg stationary hop

- *Procedure:* Child will start with feet together on line with hands on hips. When examiner instructs child to start, child has to raise non-preferred leg behind him or herself with knee bent 90-degrees and shin parallel to the floor. The child has to hop on one leg, maintaining proper form and position.
- *Aim:* Hop as many times as possible on preferred leg for 15 seconds.
- *Trial:* Two trials.
- *Time:* 15 seconds per trial.

Subtest 7: Upper-limb coordination

Dropping and catching a boll-both hands

- *Procedure:* Child will stand and hold a tennis ball in both hands with arm extended in front of his or her body. Child has to drop the ball, let it bounce once and then catch it again with both hands. Child is allowed to move or bend over to catch the ball.
- *Aim:* Catch ball for 5 consecutive catches without trapping ball against body or catching with only one hand.
- *Trial:* Two trials, expect if child successfully caught 5 consecutive times.
- *Time:* No time limit.

Dribbling a ball-alternating hands

- *Procedure:* Child will stand and hold a tennis ball in preferred hand with arm extended in front of body. Child has to drop the ball and then bounce it with alternating hands with each dribble. Child is allowed to move if necessary.
- *Aim:* Dribble ball for 10 consecutive bounces with alternating hands.
- *Trial:* Two trials, except if child successfully dribbled ball 10 times consecutively.
- *Time:* No time limit.

Subtest 8: Strength

Knee push-ups

- *Procedure:* Place down kneepad. Child has to kneel on the kneepad and lean forward, placing hands on the floor (in push up position). Hands should be directly beneath the shoulders. Child has to cross ankles and raise feet off the floor with back and neck straight, looking at the floor. Child has to perform knee push-ups until examiner stops him or her.
- *Aim:* Perform as many knee push-ups as possible in 30 seconds, maintaining proper form.
- *Trial: One trial.*
- *Time: 30 seconds.*

Sit ups

- *Procedure:* Child will lie on back on the floor, arms resting at sides with palms facing down. Their knees have to be bent 90-degrees, with feet flat on the floor.

- Child has to perform sit-ups, raising head, shoulders and shoulder blades off the floor, reaching for his or her knees with hands and the lower back down to floor. Continue until examiner stops.
- *Aim:* Perform as many situps as possible in 30 seconds maintaining proper form.
- *Trial:* One trial.
- *Time:* 30 seconds.

ADAPTED FROM: BRUININKS, R.H. & BRUININKS, B.D. (2005). *Bruininks-Oseretsky Test of Motor Proficiency* (2nd ed.). Minneapolis, MN: Pearson.

APPENDIX H

PERCEPTUAL-MOTOR INTERVENTION

WEEKLY LAYOUT:

Week	Lesson number	Focuses	Theme
1	1	Letter recognition & Bilateral coordination	Farming
2	2	Directionality & Bilateral coordination	Firefighter
	3	Directionality & Bilateral coordination	Airplanes
3	4	Spatial Awareness & Bilateral coordination	Builders
	5	Spatial Awareness & Bilateral coordination	Artists
4	6	Visual perception & Directionality	Superhero's
	7	Visual perception & Directionality	Gardening
5	8	Spatial Awareness	Going to space
6	10	Visual perception & Letter recognition	Ice cream
	11	Visual perception & Letter recognition	Sailors
7	12	Directionality	Rainbow
	13	Directionality	Hot air balloon
8	14	Visual perception	Grocery shopping
9	15	Sight word recognition	Cars
10	16	Spelling and Bilateral coordination	Candyland
11	18	Spatial awareness & Spelling	Going to the beach
	19	Spatial awareness & Spelling	Baking
12	20	Spatial awareness & Spelling	Circus
	21	Spatial awareness & Spelling	Zoo

SESSION LAYOUT

1. Stimulation exercise (5 minutes)

Before each session, begin with body outline with children:

- Start at top of head and apply pressure.
- Move down to ears and massage top, middle and lower ear. Repeat these 3 times.
- Apply pressure to shoulders.
- Apply pressure on left arm while moving from shoulder to hand. Massage each finger individually. Repeat with right arm.
- Apply pressure to sides of body while moving down.
- Apply pressure to left leg while moving all the way down to feet. Repeat with right leg.
- 'Plant' friend's ankles by holding onto them and pushing them down into the ground for 10 seconds.

  ADAPTED FROM: DE JAGER, M. & VICTOR, L. (2017). Play, Learn, Know: A chid is a work in progress. Welgemoed: Metz Press.

2. **Warm up (7 minutes)**
3. **Activity 1, 2, and 3 (15 minutes each: 45 minutes total)**
4. **Cool down (3 minutes)**

SCHOOL FACILITIES SIZE

School A

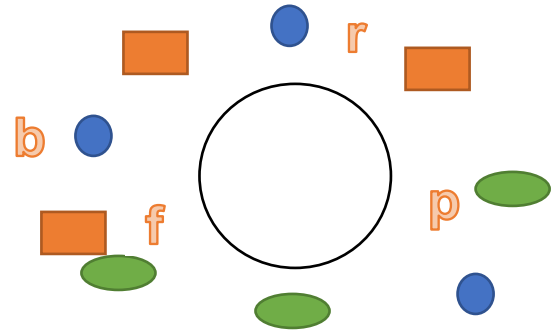
- Testing hall: 10m x 10m
- Classroom: 95m^2
- Intervention hall: 180m^2
- Outside field: Rugby field (120m x 70m). Only half the field was used.

School B

- Testing and intervention hall: 20m x 10m
- Classroom: 95m^2
- Outside field: Rugby field (120m x 70m). Only half the field was used.

WEEK 1 SESSION 1 **Theme**: Farming		
Main focus: Letter recognition & Bilateral coordination		
Equipment: Baskets, blackboard, tactile feet, hula hoops, hula hoop stand, foam letters, big shapes, ropes, colour rocks, alphabet beanbags, cones, balloons, stilts		
SET UP	**DESCRIPTION**	**PRESENTER NOTES**
Warm up Extra focuses: Strength, motor planning & proprioception		
Place baskets with animal pictures in them at one end of the room. Each animal will have one of the following letters on them: a,b,d,p,q,o. 10m away there will be 3 blackboards in a row. Each blackboard will have 2 letters written on them. (Same as mentioned above).	*Storyline: All of our animal friends on the farm are lost. Let's help them get back to their home.* • Children will all stand at the baskets and take one of the animal pictures (See Appendix H: Image 1). • They will listen to instructions from the presenters and follow them to place the correct animal at the correct letter on the blackboard. ○ Run/ Bear walk/Cross lateral walk. • When they placed on picture on the correct letter, they will move back again the way they came and take another picture until all the animals are in their homes.	Presenters should note if children struggle with letter reversals for 'b', 'd', 'p', and 'q'.
Activity 1 **Extra focuses**: Spatial awareness, hand-eye coordination & strength		

10 tactile feet will be placed in a line. In front of the feet a hula hoop will be placed on a stand. Beanbags will be placed on the other side of the hula stand.
 
	Storyline: Let's go collect some vegetables in the field. Make sure you get the correct one.
	• Children will start behind the tactile feet and walk on them. They must bear crawl through the hula hoop.
	• They will pick up a beanbag and throw it from the one hand to the other until they reach the basket with pictures.
	• They will choose a picture and write the letter their vegetable begins with on the blackboard. Note the following:
	  ○ **Knowledge of correct letter**
	  ○ **Letter direction/shape**
		Presenters should assist children in the correct formation of letter as well as with the correct spelling of words.

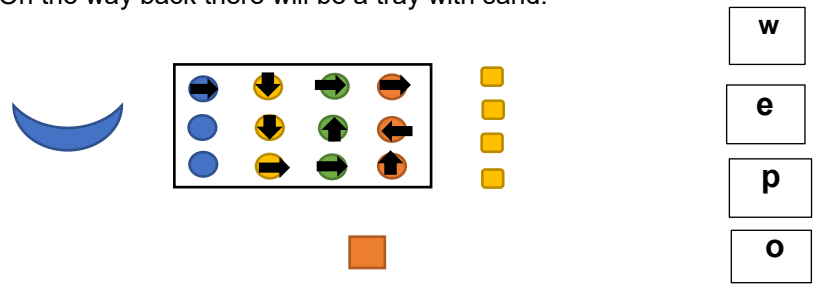
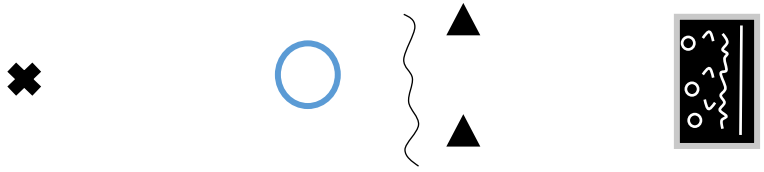
	○ **Size of letter** • They have to crabwalk back to the start (15m away). **Progression:** Children will hop on one leg on the tactile feet. **Progression:** Child will write the entire name of the vegetable **(Note spacing between letters).**	
Activity 2 **Extra focuses**: Visual motor integration (VMI), strength, whole-part recognition & dynamic balance		
Pictures will be shown to children with different shapes and letters forming a tractor. Ropes will be placed in a circle Different big shapes will be scattered all along the ropes. The following big shapes will be placed around the hula hoops: circles, foam letters, rectangles, ovals (Note any letters can be used).  	*Storyline: Our tractor is completely broken, and we need to get it back together. Look closely at the photo to build it back together correctly.* • The child is shown a picture and has to remember the shapes, letters and colours (See Appendix H: Image 2). • They must walk on the ropes and once they reach the big shape that resembles one of the shapes in their picture, they have to walk forward with their hands towards the equipment with their feet staying on the ropes. They have to collect it and move back again. • Children can continue until they have collected all the shapes to build the tractor exactly the same as in picture. **[This activity aims to develop the ability to see a picture as a whole and then break it down into its different parts.]** **Progression:** replace the ropes with colour rocks. Child will hop on 2 legs on each colour rock.	Presenters should note if children place shapes in correct order (same as picture given).
Activity 3 **Extra focuses**: Dynamic balance, strength & motor planning		
6 foam letters will be placed in a zig zag form on the ground. At the other side of the letters there will be a colour circle with alphabet beanbags scattered around it. 1.5m in front of the colour circle will be small cones with letters on them (same as on the alphabet beanbags).	*Storyline: It's time to plant some crops. Walk carefully through the field to plant your seeds.* • Children will use stilts as they walk on the foam letters, saying the letter out load to the presenter.	Presenters can correct and assist child in the correct naming of the letters and should assist children with performing cross-lateral walk correctly.

	• Children have to stand with both feet on the colour circle at the end of the letters. • Children will pick up a beanbag and walk forward with their hands while feet stay on the colour dot. • They will 'plant' the seed by placing the beanbag under the cone with the same letter. **[Child should be able to match like letters].** • Once they are done, they can cross lateral walk back to start. **[This cross-body movement strengthen the network between the two sides of the brain]** **Progression:** a rope will be placed in a swivel shape running in between the letters. Child will get alphabet beanbags at the start and must throw the correct letter beanbag on the correct letter as they walk heel-toe on the rope. **Progression:** Child has to say a word starting with the letter they step on.	
Cool down **Extra focuses**: Hand-eye coordination		
	Storyline: Carefully pass the eggs in the circle to get them home. • Children will sit in a circle while 5 balloons with letters written on them will be passed around the circle. • When presenter says stop, the children holding the balloon should say the letter written on the balloons as well as a word starting with that letter.	

WEEK 2 SESSION 2 **Theme:** Firefighter		
Main focus: Directionality & Bilateral coordination		
Equipment: Ropes, cones, poles, tactile feet, colour circle/dot, tactile hands, tilt board, twister mat, arrows, beanbags, letters, sand, hula hoop & blackboard		
SET UP	**DESCRIPTION**	**PRESENTER NOTES**
Warm up **Extra focuses:** Motor planning, aerobic capacity & agility		

Layout 2 ropes 20m apart.
Children will stand in a line behind each other.
	Storyline: Follow the sign to put out all the fires quickly.
	• The children will do jumping jacks while waiting in line.
	• When they get to the front the present will show the child a 'b' or 'd'.
	  ○ b: child runs to the right.
	  ○ d: child runs run to the left.
	• The children must respond quickly, run to the correct side rope, touch the rope and run to the back of the line.
		If children struggle with the direction of the letter, explain activity as follows; "Run to the side in which the letter's belly is pointing".

Activity 1 **Extra focuses:** Strength, motor planning & laterality		
2 sets of big cones with poles through them will be placed in front of each other, 3m apart (Forming a hurdle). (4 cones 2 poles). 4 pairs of tactile feet will be placed in a line. Each pair should face in another direction. - Point to the front/right/left/back/diagonal. After the tactile feet will be a colour dot and 1.5 m away will be 4 tactile hands (both left and right). 	*Storyline: Quickly get into the building the stomp out the fire.* • Children will line up behind colour cones. • They will crawl under the first pole and hop over the second one. **[This instruction must be given at the start of the activity to see if children are able to follow and remember directions.]** • Once they reach the tactile feet, they must see in what direction the feet point and face in that direction as they hop onto them. • They will stand on the colour dot and walk forward with their hands towards the tactile hands. • They must then clap a tactile hand with the correct hand. Repeat with all 4 hands.	Presenters should note if child is able to correctly plan movements and place down correct hand/foot on the tactile hand/foot.

	• Children will crabwalk all the way back to the start. **Progression:** child will caterpillar walk back to start.	
Activity 2 **Extra focuses:** Vestibular stimulation, motor planning, hand-eye coordination & tactile stimulation		
A tilt board will be placed down at the start of the activity. A twister mat will also be placed down. On each colour dot on twister mat there will be arrows making a path. At the end of the twister mat there will letter beanbags. 2m away there will big laminated sheets with letters (any letters can be used). On the way back there will be a tray with sand.  	*Storyline: Find your way out of the burning building.* • Child will stand on the tilt board and tilt it 5 times to each side. **[This is to provide vestibular stimulation to organize sensory system].** • Child will hop on the arrows following the direction until they reach the other side of the twister mat. • At the end, child will pick up a letter beanbag and throw it onto the correct letter. • Child must draw that letter in the sand tray. **[Sand provides an extra sensory experience, enhancing learning].** **Progression:** ropes will be placed down on the way back. Child will form the letter using ropes. **Progression:** hop on 1 leg on the arrows.	Presenters should ensure children draw the letter in the sand correctly. If child struggles, hold child's hand and move their hand in the sand to draw letter. Repeat this a few times.
Activity 3 **Extra focuses:** Motor planning & dynamic balance		
A hula hoop will be placed 5m from the start. 2 cones will then be placed 1 meter apart with a rope and on the other side of the cones will be a blackboard with drawings on it: - Straight line, swivel line, parallel lines, < signs, > signs, circles. 	*Storyline: We must get the fire truck ready for the next emergency call. Make sure you clean and pack it correctly.* • Children will receive stickers that will be stuck on their right elbow and left knee **(this is to help them with the cross lateral walk)** and cross lateral walk to the hula hoop. • They will walk heel-toe around the hoop (in **clockwise** direction). **[They must walk in a clockwise direction as letters are written in a clockwise direction (for example, o/p].**	Presenter should ensure children perform the different actions in the correct direction (as mentioned in description).

	• Children must lay a rope down from one cone to the other (from **left to right).** **[They must lay it down from left to right as this is the direction one reads in].** • Child will use a cloth to clean the drawings off the board. **[Always from left to right, top to bottom or in clockwise direction].** **Progression:** heel-toe walks backwards around the hoop. **Progression:** child will draw the drawings on the blackboard.	
Cool down **Extra focuses:** Motor planning, agility & vestibular stimulation		

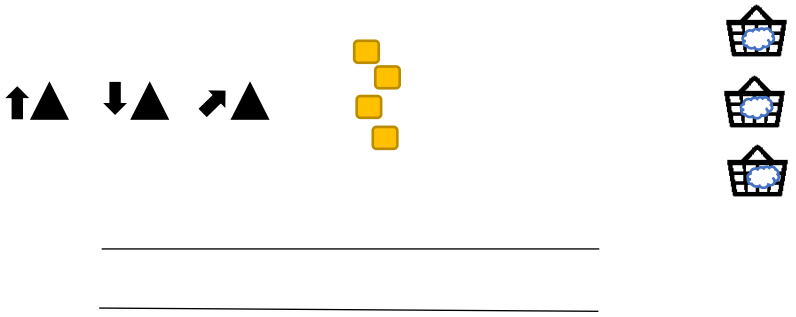
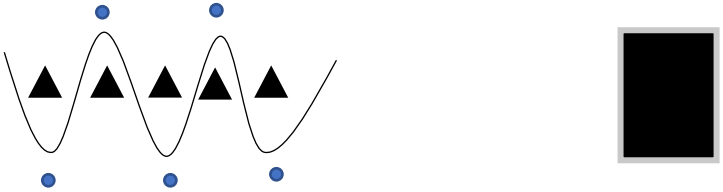
	Storyline: Stop, drop and roll.
	
	• Children will stand in a circle.
	• They will run on the spot and listen to instructions:
	  ○ Stop: freeze on the spot.
	  ○ Drop: go down in push up position.
	  ○ Roll left/right: roll to the left or right.	

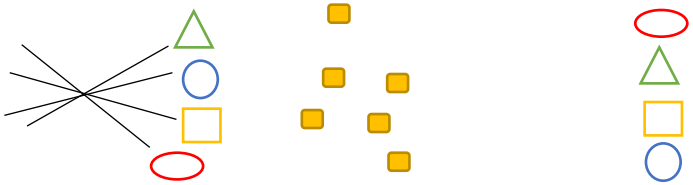
WEEK 2 SESSION 3 **Theme:** Airplanes		
Main focus: Directionality & Bilateral coordination		
Equipment: Cones, arrows, beanbags, baskets, cloud pictures, ropes, colour balls, blackboard & shapes		
SET UP	**DESCRIPTION**	**PRESENTER NOTES**
Warm up: **Extra focuses:** Body awareness & laterality		

	Storyline: It's time to take off into the sky! Listen closely to instructions
	
	• Children will all stand in a circle.
	• They put out their arms to the sides like airplane wings.
	• They will run in a circle and listen to the presenter's instructions.
	  ○ 'Turn left': children have to touch the ground with their left arm.
	  ○ 'Turn right': children have to touch the ground with their right arm.
	  ○ 'Fly up': children have to leap through the air.
	  ○ 'Fly down': children have to crouch down low and walk like ducks.	

Activity 1: **Extra focuses:** Spatial awareness & letter recognition		

3 cones with arrows pointing in different directions will be placed in a line (presenter can change the direction of the arrow as activity progresses).
Letter beanbags will be placed on the other side of the cones.
Pictures of clouds with a letter in each of them will be stuck onto baskets.
On the way back to the line there will be 2 ropes placed parallel to each other about 30cm apart.
	Storyline: Touch the clouds as you fly.
	
	• Children will put their hands out to their sides like an airplane and will run towards the cone.
	• When they reach the cone, they must follow the arrow:
	  ○ Arrow pointing to left side: run around the cone clockwise.
	  ○ Arrow pointing to right side: run around the cone anti-clockwise.
	  ○ Arrow pointing up: Hop over cone.
	  ○ Arrow pointing down: crab walk around cone.
		Presenters should ensure children follow the direction of the arrows correctly, as well as perform the correct action that goes with the arrow.

	**[This will assist with children's laterality and directionality].** • The child has to pick up 2 letter beanbags and place them on top of their hands (arms still stretched out) and run to the correct cloud and drop the letter beanbag in the same letter basket. • Once they are done, they will walk on their toes in between the 2 ropes. **[This is to assist with spatial awareness].** **Progression:** place tactile feet inside and outside the 2 ropes, children have to hop on the tactile feet on their way back to the line. **Progression:** children will hop on one leg around the cones.	
Activity 2: **Extra focuses:** Balance & memory		
Place 5 cones in a row with a rope in a zig zag pattern in between them. Place colour balls in a line next to the cones. 5m away place a blackboard with chalk. 	*Storyline: Make sure you land in the correct country. Follow all the directions very carefully.* • Children will be shown a picture at the start of the activity of 3 arrows pointing in different directions (show picture for only 10 seconds). • Child will heel-toe walk on the rope and will pick up a colour ball with one hand, place it in the other and then place it on the cone. **[This is to assist with bilateral coordination].** • When they reach the end of the rope, they must homolateral walk (**same arm and leg up**) towards the blackboard. • When they reach the blackboard, they have to draw the arrows shown to them at the start of the activity. • Child will then run back to the line (like an airplane). **Progression:** Hop over beacons with one leg (take away rope). **Progression:** Cross-lateral walk to blackboard	Presenter should encourage children to remember the order and direction of arrows shown on the picture at start of activity. Children who struggle to remember, may be shown the picture again.

<table>
<tr><th colspan="3">Activity 3:
Extra focuses: Visual motor integration, memory, strength & hand-eye coordination</th></tr>
<tr><td>Set out 4 ropes overlapping each other.
At the end of each rope place a colour shape with a letter inside.
After the colour shapes scatter letter beanbags around (upside down) and then place down a line of colour shapes again (same as at the ropes).
  </td><td>Storyline: Let’s go get all the passengers and make sure they arrive safely at their destinations.

• Children will be shown a letter at the start of the activity and have to remember it.
• They will follow the rope leading to the same letter in a shape. They must remember in what shape their letter was.
• Children will crabwalk in between the beanbags, turning them around until they find their letter.
• Once they found it they can stand up on 1 leg and throw the beanbag into the correct shape.
• They will run like an airplane back to the start.

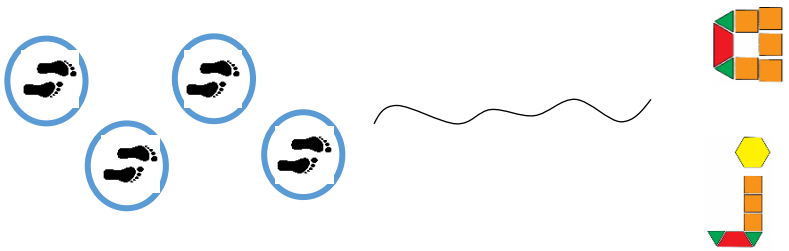
Progression: children will hop on 1 leg while looking for their letter beanbag.
Progression: after they threw the beanbag, they can draw their shape and letter on a piece of laminated paper.</td><td></td></tr>
<tr><th colspan="3">Cool down:
Extra focuses: Body awareness & laterality</th></tr>
<tr><td></td><td>Storyline: Clean your plane!

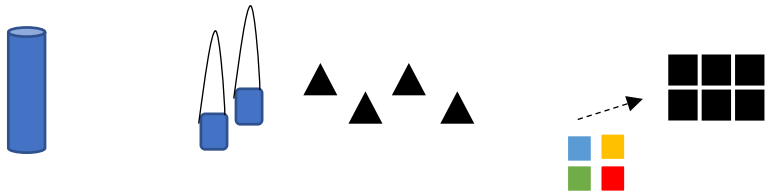
• Children will stand in a circle and listen to instructions:
  ○ ‘Wash your right/left knee’: rub right/left knee with beanbag.
  ○ ‘Wash your right/left arm’: rub right/left arm with beanbag.
  ○ ‘Wash the top of your plane’: rub top of head.
• Can repeat with any body part and any side of body.</td><td></td></tr>
</table>

WEEK 3 SESSION 4 **Theme:** Builders		
Main focus: Spatial awareness & Bilateral coordination		
Equipment: Ball, rope, beanbags, blackboard, hula hoops, tactile feet, puzzle letters, foam roller, stilts, cones, blocks & colour squares		
SET UP	**DESCRIPTION**	**PRESENTER NOTES**
Warm up **Extra focuses:** VMI & shape recognition		

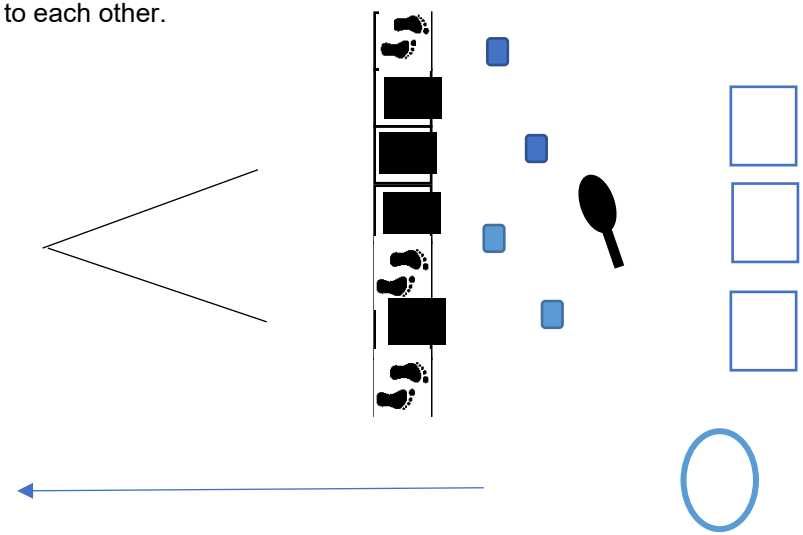
	Storyline: We have to learn about all the different shapes of building and try to build them as quick as possible.
	
	• Children will be split into groups of ten.
	• Each group must listen to instructions:
	  ○ Make a square: Children must form a square with their group with your group.
	  ○ Make a circle: Form a circle with your group.
	  ○ Make a triangle: Form a triangle with your group.
	  ○ Make a rectangle: Form a rectangle with your group.	

Activity 1 **Extra focuses:** Strength, motor planning & letter recognition		
3m away from the start, put down 2 ropes in a straight line with a ball at the beginning. Place letter beanbags at the end and a blackboard with a grid drawn on it. 	*Storyline: Let's move all the bricks to the building site.* • Child will be shown a picture of a grid with letters in it and has to remember the spacing and position of the letters (See Appendix H: Image 3) **[This is to assist with spatial awareness and memory].** • Child will caterpillar walk towards the rope and roll the ball on the rope while walking. **[This will assist with spatial awareness and with writing on a line].** • Child has to pick up the correct letter beanbags and place them as they saw on the picture. If the child	Presenter should ensure child places letter beanbags in the same position as shown in the grid. Assist children by asking them which letter is in the top left or bottom right corner for example.

	struggles to remember the picture may be shown again. • Children must wheelbarrow walk back to the start with the person at the other station. **Progression:** child will bear walk on rope while rolling ball. **Progression:** child will stand on a colour circle while walking forward with hands to place beanbags on the blackboard.	
Activity 2 **Extra focuses:** VMI, whole-part recognition & dynamic balance		
Set out 4 hula hoops in a zig zag pattern (each 1 m apart). Place 2 tactile feet in each circle. Place a rope in a swivel shape. Place down a letter puzzle at the end of the rope. 	*Storyline: Time to build our house.* • Child will hop with 2 feet into each circle, landing on the tactile feet and then walk heel-toe backwards on the swivel rope. • Child will be shown a picture of a letter made out of different shapes and has to build it using the puzzle shapes provided (Appendix H: Image 4). • Child will cross lateral walk back to the start. **Stickers can be provided to help child do it correctly.** **Progression:** place tactile feet in different patterns in the circles: 1 foot inside, 1 outside, 2 outside, etc. **Progression:** place colour cones on both sides of the rope. Child will roll colour balls into the cones while balancing on the rope.	Presenters can assist children with building the letter puzzles, ensuring they place the shapes in the correct order and orientation to form the letter
Activity 3 **Extra focuses:** Vestibular stimulation, dynamic balance & motor planning		
Place a foam roller at the start of the activity. 5m away from start, place down 4 small cones in a zig zag pattern close to each other with a pair of stilts. Place down blocks by building a wall.	*Storyline: Time to paint our house. Make sure you follow the instructions clearly.* • Child will be shown a picture of how the wall should be 'painted' (Appendix H: Image 5). • Children have to roll over the foam roller, walking forward on their hands until the roller is at their feet. • They will walk with the stilts by stepping onto each cone.	Children should be able to replicate picture exactly, not confusing the position of the colour squares.

	• Children has to stick on pieces of colour paper onto the brick 'wall' using prestick. Pictures can be placed next to the wall to assist child. **Progression:** child will walk around each cone with stilts (complete circle). **Progression:** instead of colours, there will be letters and symbols drawn on the wall picture. Child has to draw them onto the block using chalk.	
Cool down **Extra focuses:** Motor planning & directionality		
	Storyline: We must pack up all our stuff now that our home is done. • Children will stand in a circle and receive a tennis ball. • The first child has to pass the ball over their head, and the next person will pass it through their legs. Continue this pattern. • Children also has to listen to instructions when presenters say, 'Change direction'.	

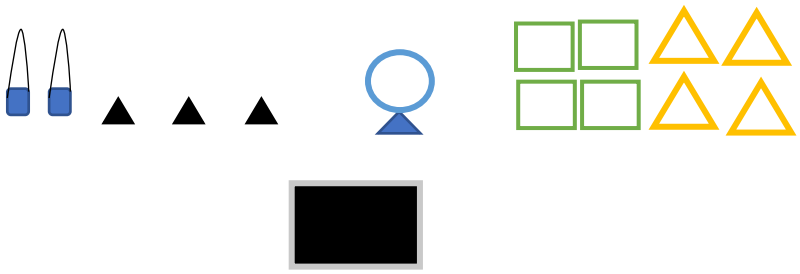
WEEK 3 SESSION 5 **Theme:** Artists		
Main focus: Spatial awareness & Bilateral coordination		
Equipment: ropes, agility ladder, tactile feet, beanbags, beach bat, squares, hula hoop, masking tape, colour rings, cones, letters, playdough, stilts, cones, hoop stand, shapes, blackboard & colour balls		
SET UP	**DESCRIPTION**	**PRESENTER NOTES**
Warm up **Extra focuses:** Dynamic balance & colour recognition		
Colour balls and hula hoops will be spread out. Big colour cones will be packed out around it (one of each colour: blue, green, red, yellow).	*Storyline: Get all the paint into the correct colour buckets to take to our art room.* • Children have to collect the colour balls and place them into the correct cone by hopping with 2 feet into only the hula hoops.	

<table>
<tr><th colspan="3">Activity 1
Extra focuses: Directional awareness, balance, strength & hand-eye coordination</th></tr>
<tr>
<td>Two ropes will be placed in a V formation (close end at the start of activity).
There will be an agility ladder placed down horizontally with tactile feet in each block (can be 1 or 2 feet per block). On the other side bean bags will be spread out with a beach bat and 3 hopscotch squares placed next to each other.
  </td>
<td>Storyline: Let’s paint a picture.

• Children will start by plank walking on the rope (spreading out as it goes wider). [This develops spatial and body awareness].
• They will hop sideways through the agility ladder landing only on the tactile feet.
• Children will be shown a picture that has 3 squares in a line with colour squares in them at different positions in the square (Appendix H: Image 6).
• The child has to copy the picture by hitting the beanbags into the hopscotch squares in the same position as on the picture. [This is also for developing directional awareness as child must remember if the colours were in left/right/top/bottom corner of the square].
• Child will run back to the start by skipping with a hula hoop.
Progression: tactile feet will be placed randomly around the ropes. Child must hop onto tactile feet.
Progression: child will caterpillar walk through the agility ladder.</td>
<td>Presenters should ensure children place the beanbags in the exact position as shown in picture and that they do not get confused between left/right and top/bottom.</td>
</tr>
<tr><th colspan="3">Activity 2
Extra focuses: Hand-eye coordination, balance, letter formation & tactile stimulation</th></tr>
<tr>
<td>Place 5 short pieces of masking tape in a zig zag (one piece going left, one right) on the ground.
On either side of each piece of masking tape, place tactile feet.
Lay down a rope and on the other side place colour rings and 3 cones in a straight line.
On the way back spread out laminated letters (can be any letter) and playdough.</td>
<td>Storyline: Time to make a sculpture.

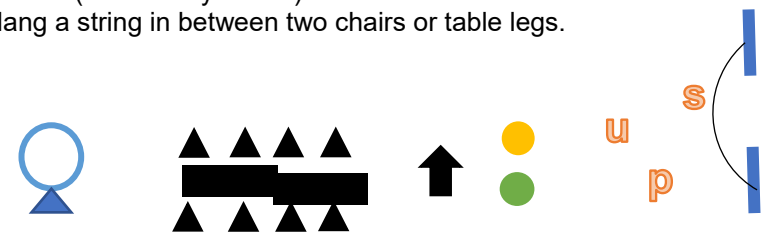
• Children will hop on the tactile feet towards the rope and then hop sideways (left and right) over the rope.
• Once they reach the end, they have to pick up a colour ring and throw it over the cones.
• Children will then form the letter using playdough.

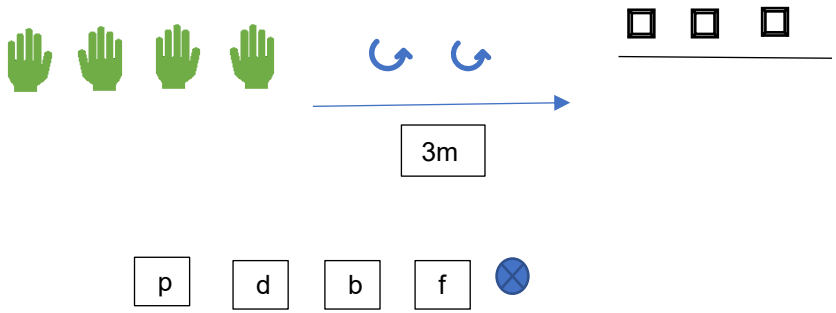
Progression: take tactile feet away from the lines.
Progression: child will hop backwards over the rope.</td>
<td>Presenter should assist children to form the letter using the playdough, ensuring they understand in what direction the letter is pointing as well as what the name of the letter is.</td>
</tr>
</table>

Activity 3 **Extra focuses:** Balance, strength & VMI		
Stilts will be placed at the start of the activity. There will then be 3 cones placed in a straight line and a hula hoop on a stand. On the other side of the hula hoop will be 4 squares and 4 triangle shapes. On the way back will be a blackboard with chalk. 	*Storyline: Let's hang up all our beautiful creations.* • Children will walk with the stilts (zig zag) through the cones and bear walk through the hula hoops, avoiding touching the sides. **[This helps develop spatial awareness and will assist child to have the correct spacing in between words and letters and to write on the line].** • They will be shown a picture of squares and triangles in different patterns (Example in Appendix H: Image 7) • They have to remember the image and make it use the hopscotch squares and triangles. • On the way back they must draw that picture on the blackboard. **[This also helps with child's spatial memory].** **Progression:** children will crabwalk through the hula hoop. **Progression:** once children completed the picture, they have to hopscotch jump through it.	Encourage child to try remember picture shown to him/her and to replicate it exactly.
Cool down **Extra focuses:** Hand-eye coordination & proprioception		
	Storyline: We have to finish our canvas by painting it all sorts of different colours • Children will sit in a circle and receive a colour ball. • In the middle of the circle will be a hula hoop. • The children need to roll their colour ball into the hula hoop or as close as possible to the hula hoop.	Give feedback to children if they roll ball too hard or too soft to help correct action for the next try.

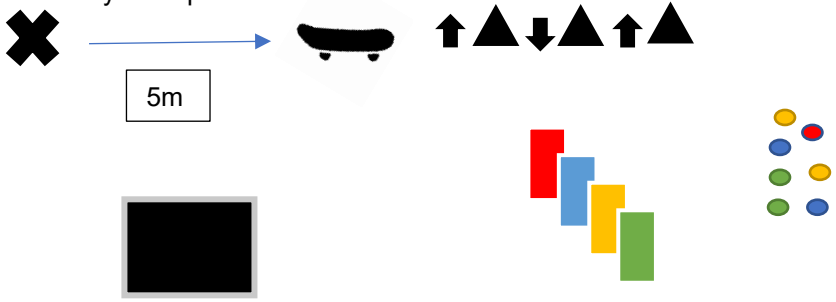
WEEK 4 SESSION 6 **Theme:** Superheroes		
Main focus: Visual perception & Directionality		
Equipment: arrows, hula hoops, hula hoop stand, cones, tactile feet, colour circle/dots, letter, string, tactile hands, rope, superhero pictures, medicine ball, scooter board, colour balls, colour buckets & blackboard		
SET UP	**DESCRIPTION**	**PRESENTER NOTES**
Warm up **Extra focuses:** Motor planning & laterality		

	Storyline: Follow the signs to the villain.
	
	• Children will spread out and the instructors will show an arrow. The children have to complete the action associated with that arrow.
	  ○ Left arrow: hop with 2 feet to the left.
	  ○ Right arrow: hop with 2 feet to the right.
	  ○ Up arrow: jump as high as you can and reach for the sky.
	  ○ Down arrow: drop down in a push up position.
		Explain the activity to the children at the beginning of the warm-up and encourage them to remember actions that go with the arrows.

Activity 1 **Extra focuses:** Spatial awareness, body awareness, dynamic balance, laterality & letter recognition		
Set up a hula hoop on a stand. Place down 4 tactile feet in a line in front of each other (left and right feet). Next to each foot (on both sides), place a cone. Place down arrow (pointing left or right) and then in front of it place down 2 colour dots next to each other. (repeat again once). Next place down a picture with 3 letters and scatter random foam letters around (can be any letters). Hang a string in between two chairs or table legs. 	*Storyline: Spiderman. Use your Spidey-Web to get all the villains.* • Child will crawl through the hula hoop and then hop on each foot (with the correct foot), using his other leg to kick over the cones. • Child has to frog jump onto the left or right colour dot (depending on arrow). • Child will be told to collect 3 letters. • Child then has to collect those 3 foam letters and hang it on the string between 2 table legs/ on the fence. • Child will do homolateral walk back to start. **Progression:** crab walk through the hula hoop. **Progression:** child will write down words starting with the letters they hang up on a blackboard.	

<table>
<tr><th colspan="3">Activity 2
Extra focuses: Strength, spatial awareness, laterality, body awareness & letter recognition</th></tr>
<tr>
<td>Place down a row of 4 tactile hands (can be left and right hands randomly)
3m away place down a rope with Superman pictures next to it.
On the way back place down laminated letters and a medicine ball.
 
</td>
<td>Storyline: Superman. We want to be just like Superman, make sure you copy him exactly.

• Chid will plank walk on the row of hands, placing down the correct hand on the correct tactile hand (can cross over with hands as well) and then log roll towards the rope.
• Child will walk heel-toe on the rope. As he reaches a picture (Appendix H: Image 8) he has to copy that Superman picture with his/her body (not mirror). [It is important for child not to mirror the image, therefore, if the left arm is lifted in the picture, child must lift his/her left arm].
• Child will receive the list of villains (which will be a list of letters) and have to bounce a medicine ball on those letters as he/she walks back.

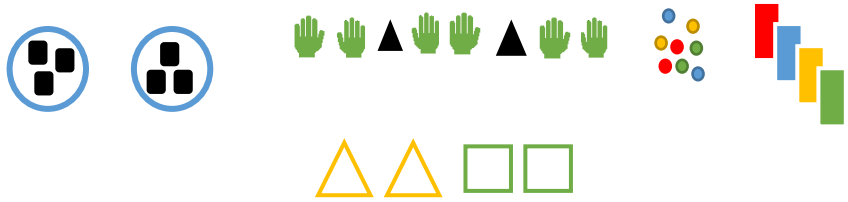
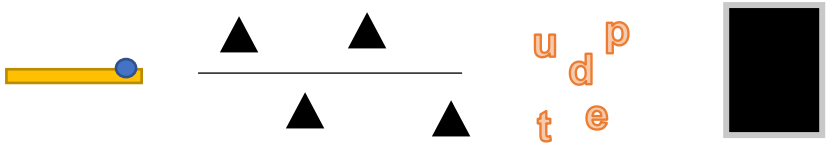
Progression: child will make a word as a bounce the ball on the letters.
Progression: child will caterpillar walk to the rope.</td>
<td>Ensure children do not mirror image.</td>
</tr>
<tr><th colspan="3">Activity 3
Extra focuses: Strength, colour recognition & letter formation</th></tr>
<tr>
<td>5m from the start place down a scooter board with a rope attached to it.
Next place down 3 cones with arrows pointing in different directions.
Place down colour balls and 4 colour buckets in a straight line (vertical).
On the way back place down a blackboard with chalk.
 
</td>
<td>Storyline: Batman. Get your Bat-mobile as quick as possible to go get some villains.

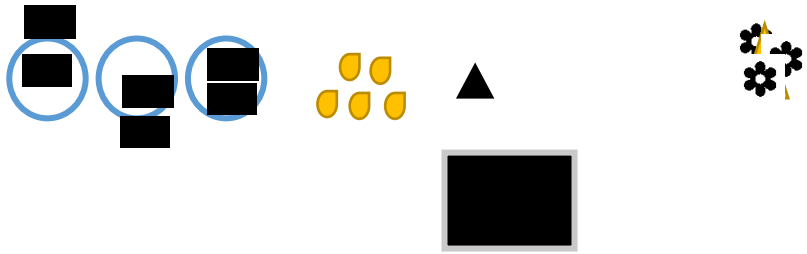
• Child must pull the scooter board closer while in squat position using the rope.
• Child will then get onto scooter board and push himself towards the cones and navigate between the cones (following the direction of arrows).
• Child will leopard crawl towards the colour balls and throw a ball into each cone (matching the colours).
• On the way back the child will write down one of the letters to spell ‘batman’ (1st child writes b, 2nd a, etc. restart once batman is spelt).</td>
<td></td>
</tr>
</table>

	Progression: one child will push the other child through the course on the scooter board. **Progression:** place down colour cones horizontally and flat, child will roll in the ball under through legs (facing other way).	
Cool down **Extra focuses:** Body awareness & laterality		
	Storyline: Follow the superhero. Copy all your favourite superhero moves. • Children will pair up with a partner. • One child will be the superhero. • The superhero will make different movements and the other child will copy the movements (not mirroring).	

WEEK 4 SESSION 7 **Theme:** Gardening		
Main focus: Visual Perception & Directionality		
Equipment: Gardening tool pictures, hula hoops, beanbags, tactile hands, cones, colour balls, colour buckets, shapes, Step-n-catch, rope, letters, blackboard, tactile feet, petal pictures & cut-out flowers		
SET UP	**DESCRIPTION**	**PRESENTER NOTES**
Warm up **Extra focuses:** VMI & strength		

	Storyline: What do we do in a garden?
	• Children will be shown pictures of different gardening tools. Each tool will have a movement associated with it and children must execute that movement:
	  ○ Shovel: do mountain climbers.
	  ○ Watering can: touch the sky, touch the floor (make rain movement with fingers as you go down).
	  ○ Lawn mower: run to side while 'pushing lawn mower'.
	  ○ Wheelbarrow: crabwalk to the side.	

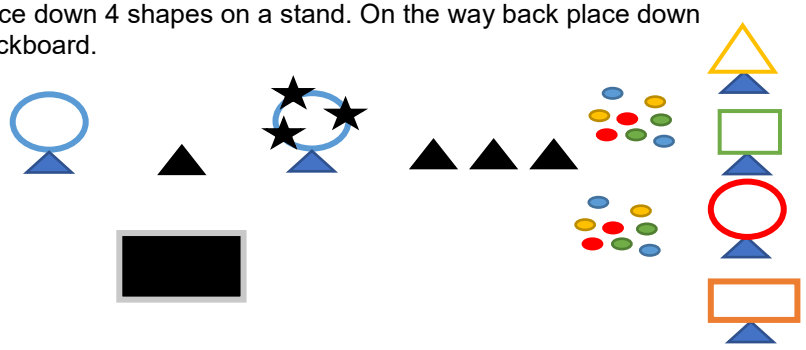
Activity 1 **Extra focuses:** Strength, bilateral coordination, spatial awareness, colour recognition & motor planning		
Place down 2 hula hoops in front of each other (2m apart) with 3 beanbags in each one. Next place down 2 tactile hands, a cone, 2 tactile hands a cone and another 2 tactile hands and a cone (6 tactile hands, 2 cones). Place down colour balls and 4 different colour cones upside down 1m away from it (standing next to each other). On the way back place down a line of 2 triangles and 2 squares. 	*Storyline: We have to dig some holes to plant all our seeds* • Children will start with their hands in the hula hoop in a push up position and must use alternating hands to throw the beanbags out of the hula hoop (staying in push up position). • Children will move to the tactile hands (in plank position) and turn their body over the cone and place hands onto the other hands in a crabwalk position. Repeat until they reach last 2 hands. (They will move from plank position to crabwalk position). • Children will then throw the colour balls into the colour cones. • On the way back children must hopscotch through the triangles and squares: triangle: 1 hop leg, square: 2 leg hops. **Progression:** children first have to do a burpee in the hoop before throwing out the beanbags (legs in and out). **Progression:** place triangles and squares in a zig zag pattern.	Explain to child to use both hands alternating when moving beanbags out of the hula hoops. Presenters can also tell child to move beanbag left/right, and child has to use left/right hand.
Activity 2 **Extra focuses:** Hand-eye coordination, proprioception, dynamic balance, letter recognition & bilateral coordination		
Place down a Step-n-catch with a colour ball. Lay down a rope and all along the rope place down cones with colour letters on them. Next scatter out foam letters and place down a blackboard on the other side. 	*Storyline: Let's plant all our seeds so that we can get beautiful flowers.* • Children will stomp on the step-n-catch and try catch the ball. • Child will walk on the rope heel-toe and has to look for the letter that is the same colour as the ball they caught. • Child has to place the ball down onto the foam letter resembling the letter on the cone and the hop on one leg around the letter (to give the seeds water). • Child must write down a word starting with their letter on the blackboard and cross-lateral walk back to start.	If children struggle to identify words that starts with the letter they picked, presenters can give the child a word that they have to write down.

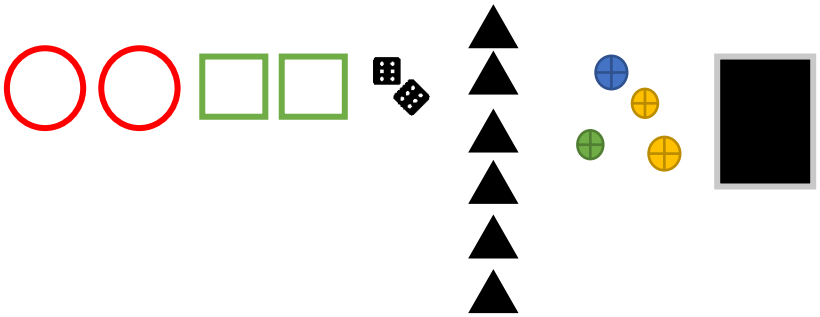
	Progression: walk backwards on rope. **Progression:** when the child finds the cone with the same colour as their ball, they have to pick up the cone and look at a picture of a flower. They have to remember how many petals the flower hand and draw that on the blackboard at the end.	
Activity 3 **Extra focuses:** Spatial awareness, whole-part recognition & letter recognition		
Set out 3 hula hoops in a line. Randomly place left and right tactile feet inside and outside the hula hoops. Next place down flower petals (out of paper) with letters on them. Place down a cone with a letter under it (instructor to change letter after each child). There will be paper flowers with letters on them stuck onto a big cone. On the way back will be a blackboard with letters written on it. 	*Storyline: Our flowers have grown beautifully. Let's go pick some flowers.* • Children will hop through all 3 hula hoops only stepping onto the correct side tactile feet. • Child has to make a word using the flower petals (sticking it around a circle in correct order of word). **[Child must identify every letter of a specific word, find the letters and place them back in the correct order to form the word].** • Child will collect a letter under the cone and has to collect the flower that has the same letter and stick it onto the blackboard in the correct space on the way back. **Progression:** children will draw the flower and letter on the blackboard. **Progression:** children will bounce a ball as they hop through the hula hoops.	Assist children in forming the word correctly and placing letters down in the correct order.
Cool down **Extra focuses:** Flexibility, VMI & body awareness		

	Storyline: Time to smell the flowers.
	
	• Children will all stand in a circle and follow the following instructions:
	  ○ Flowers are opening: Children stand on toes and spread out arms.
	  ○ Flowers are closing: go down in a small ball.
	  ○ Smell the flowers: all the children run to the middle and touch hands and run back out.	

WEEK 5 SESSION 8 **Theme:** Going to space		
Main focus: Spatial awareness		
Equipment: yellow circle, hula hoops, hula hoop stands, star pictures, cones, colour balls, shapes, blackboard, dice, planet pictures, hurdle, tactile feet, stilts, rope, paper, crayons, colour rings & parachute		
SET UP	**DESCRIPTION**	**PRESENTER NOTES**
Warm up **Extra focuses:** Directionality & vestibular stimulation		

	Storyline: Flying through space.
	
	• Children will run in a circle and presenter will stand in the middle holding a yellow circle (sun).
	• The children have to copy the movements the 'sun' makes.
	  ○ Turn in clockwise/anti-clockwise direction (run in clockwise/anti-clockwise direction).
	  ○ Move up and down (hop up and down).
	  ○ Spin in a circle (child spins in a circle).	

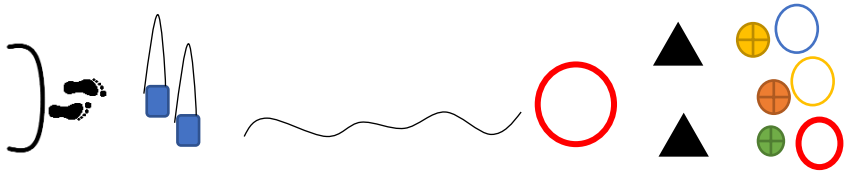
Activity 1 **Extra focuses:** Strength, letter recognition & hand-eye coordination		
Set up a hoop on a stand. Place a cone with letters under it on the other side. Place down another hula hoop on a stand and sticks stars with letters on it. Place down 3 cones in a line. Scatter colour balls around. Place down 4 shapes on a stand. On the way back place down blackboard. 	*Storyline: Look at all the shooting stars.* • Children will bear crawl through the hula hoop, get a letter under the cone and crab walk through the 2nd hula hoop. As they go through, they have to collect a star with the same letter on as the one they got under a cone. • They will crab walk around the cones (zig zag). • Child will the pick up a colour ball and stick the star on it and throw it through the correct colour shape. • On the way back child can draw the shape and write the letter in it. **Progression:** child will sit in front of shapes and stick a star onto a medicine ball and throw it through the correct shape.	Child has to remember the letter that was found as well as the shape they had to throw the ball through.

<table>
<tr><th colspan="3">Activity 2
Extra focuses: Strength, VMI, shape recognition & letter recognition</th></tr>
<tr>
<td>Set out 2 circles and 2 squares in a line.
Place down a dice with letters on every side of the dice.
Place down 6 cones with letters on them. Under each cone place down a picture of planets.
On the other side of the cones place down a blackboard and planets.
Draw planets of different sizes onto the blackboard.
  </td>
<td>Storyline: Look at all the planets. Choose one to land on.

• Child will place his/her hands inside the shapes while in a plank position and walk around it (moving hands). Repeat for all 4 shapes. [Child must trace the shapes with hands and whole body].
• Child has to throw the dice and caterpillar walk to the cone with the letter the dice landed on and memorise the pattern of planets under the cone (if they can't remember the pattern, they can keep the pattern). (Appendix H: Image 9)
• Child will collect those planets on the picture and stick them onto the blackboard in the correct size circle (matching with their planet) [This helps child judge the difference between various sizes and to be able to identify sizes that are the same].
• Child will lunge walk back to the start.

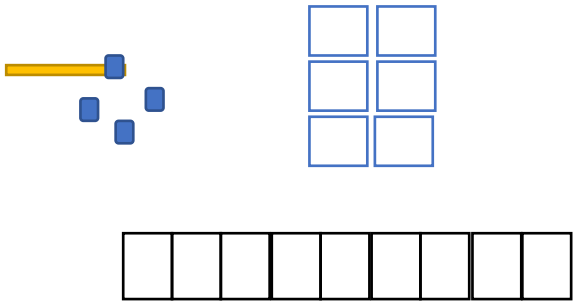
Progression: child will do a burpee in each shape.
Progression: child must do a sit up each time he sticks a planet onto the blackboard.</td>
<td>Ensure child places planets into the correct size on blackboard. Circle must not be bigger or smaller than the planet.</td>
</tr>
<tr><th colspan="3">Activity 3
Extra focuses: Dynamic balance, bilateral coordination, strength & VMI</th></tr>
<tr>
<td>Place down a hurdle with tactile feet in front at the start of the activity.
Place down a pair of stilts and a rope in a swivel shape.
On the other side of the rope will be a colour circle and 2 cones. Place a colour ball under one of the cones.
On the other side will be small colour rings with a picture of a planet and paper and crayons.</td>
<td>Storyline: What can you find on the moon? Explore under all the rocks.

• The child will hop over the hurdle with 2 feet landing on the tactile feet and then walk alongside the rope with the stilts (one foot on each side of the rope).
• Child will stand in the colour circle, walk forward with hands and lift every cone (staying in plank position) until the colour ball is found.
• Child must cross lateral walk to the colour ring that is the same colour as the ball he found.</td>
<td>Observe if children are able to correctly copy the planet picture on the piece of paper. If not, assist child by asking questions like:
- How many dots are in the circle?
- Is there a line in the circle?</td>
</tr>
</table>

	• Child will then draw the planet he has at his colour ring (Appendix H: Image 10). • Child will caterpillar walk back to start. **Progression:** remove tactile feet. Child has to crabwalk over hurdles. **Progression:** place stickers on the floor alongside the rope. Child has to step on them while walking on stilts.	- Are the dots at the left/right/top/bottom of the line?
Cool down **Extra focuses:** Vestibular stimulation		
	Storyline: Landing back on earth. • Children will all walk in a circle, holding a parachute and moving it up and down. • When the presenters say, 'meteor shower', children all have to run under the parachute and go lie down while presenters continue moving it up and down.	

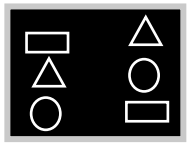
WEEK 5 SESSION 9 **Theme:** Musical instruments		
Main focus: Spatial awareness & Strength		
Equipment: Step-n-catch, beanbags, squares, agility ladder, ropes, letters, cones, rings, blackboard, foam block, medicine ball, colour dots & tactile hands		
SET UP	**DESCRIPTION**	**PRESENTER NOTES**
Warm up **Extra focuses:** VMI		

	Storyline: Playing in the orchestra.
	
	• Children will run in a circle and the instructor will tell them what instrument to play:
	  ○ Guitar: child will do a sit up and as they come up and make air guitar movements.
	  ○ Piano: child will stand in a plank position and criss-cross their hands.	

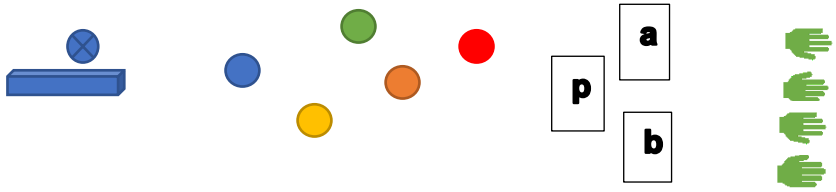
<table>
<tr><th colspan="3">Activity 1
Extra focuses: Hand-eye coordination, proprioception, VMI, spatial awareness & agility</th></tr>
<tr>
<td>Place down a Step-n-catch with colour beanbags.
2m away place down 6 squares in a grid formation.
Place down an agility ladder going back to the start.
  </td>
<td>Storyline: Let's learn to play the piano.

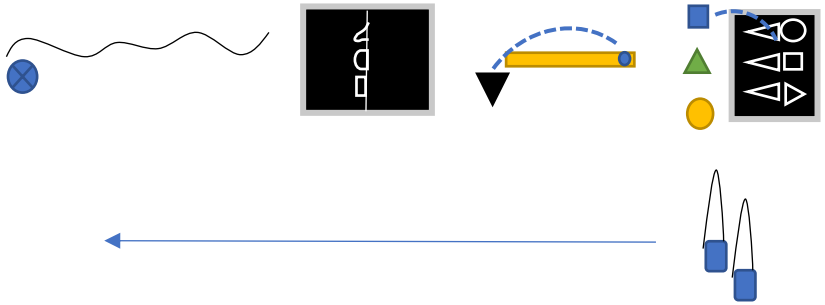
• Children will step and catch 3 beanbags.
• They will then be shown a picture of 6 blocks with some coloured in, they have to remember this pattern (Appendix H: Image 11).
• They will move forward and go into a sit up position and do a sit up. Every time they come up, they have to have to throw their beanbag into the correct block (same as picture).
• Once all the beanbags are in the correct square the child can hop on 1 leg in the blocks that has beanbags in them.
• Child will slide through agility ladder till the end.

Progression: child will caterpillar walk through the ladder.
Progression: picture will have colour rings in as well. Child has to remember which square has beanbags and which has colour rings and throw it into the grid while in a plank position.</td>
<td>If child struggles to correctly copy picture, ask child the following questions to assist them:
- How many blue squares are coloured in?
- Which squares are colours in? Top/bottom/ left/right/middle?</td>
</tr>
<tr><th colspan="3">Activity 2
Extra focuses: Letter recognition, motor planning, shape recognition & VMI</th></tr>
<tr>
<td>Layout 5 ropes in a line parallel to each other leading up to letters.
On the other side of the ropes place down 4 cones in a square (each one meter apart) with a letter at each cone.
Tie 2 rings to a rope (1 on each side).
Place down a black board and draw 3 shapes at one end of it and the same 3 shapes at the other end, but a different pattern.
 

 </td>
<td>Storyline: Time to play the guitar.

• Children will receive a paper with a picture of a hand with a letter and a picture of a foot and a letter. (Appendix H: Image 112).
• They must place their hands on the rope that has the same letter as the picture they received and place their feet on the rope leading to the other letter they received (in a plank position).
• They will plank walk all the way to the end of the ropes.
• They will then receive another paper with 2 letters: a-r / m-o etc. Child has to pick up the rope with rings and throw it over the correct cones (that have the same</td>
<td></td>
</tr>
</table>

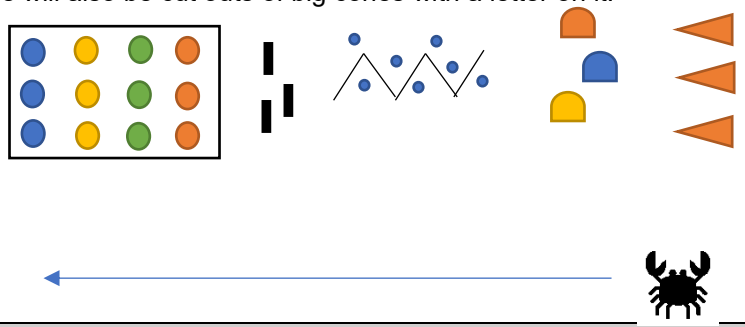
	letters as paper given), connecting one cone with the other. • Child will connect the shapes on the blackboard by drawing a line (connecting the like shapes). • Child will cross-lateral walk back to the start. **Progression:** child will receive 4 letters at the beginning and has to move hands and legs from the first 2 letter to the second 2 letters. **Progression:** child will cross-lateral walk, tapping foot behind back.	
Activity 3 **Extra focuses:** Hand-eye coordination, directionality, body awareness & temporal awareness		
Place down a foam block and a medicine ball. Spread out 5 colour dots with a letter on each one **(b or d's).** Next place down 3 laminated letters on the floor (can be any letters. And on the other side place down 4 tactile hands in a line. 	*Storyline: What can you find on the moon? Explore under all the rocks.* • Child will start by throwing the medicine ball on the foam block and catching it 3 times. • They will go to the colour dots where the instructor will tell them to hop either on all the b's or all the ds. • Child will then move to the laminated letters in a crabwalk position and receive a pattern of letters and must stomp onto the letter pattern with their feet. • Child has to plank walk on the tactile hands and squat jump back to the start. **Progression:** child will hop on 1 leg on the colour dots. **Progression:** child will bunny hop (gymnastics) by placing hands on tactile hands and kick legs up.	
Cool down **Extra focuses:** Temporal awareness & motor planning		
	Storyline: Try and follow the beat of the music. • Children will all sit in a circle andgo around the circle (clockwise) and clap hands once. • When someone claps their hands twice, the direction will change, and the will go around clapping in the anti-clockwise direction.	

WEEK 6 SESSION 10 **Theme:** Ice cream		
Main focus: Visual perception & letter recognition		
Equipment: Ropes, medicine ball, blackboard, cones, colour balls, step-n-catch, stilts, twister mat, ice-cream sticks, ice-cream scoop cut outs, cone cut outs, balloon, colour buckets, tactile hands & beanbags		
SET UP	**DESCRIPTION**	**PRESENTER NOTES**
Warm up **Extra focuses:** Directionality & strength		
	Storyline: Let's mix up all the ingredients to make our ice cream. • Children will hold hands in a circle and run in and out/ in a circle forwards/ in a circle backwards. • Once all the ingredients are mixed, they will put sprinkles on by doing high knees in a circle.	
Activity 1 **Extra focuses:** Strength, spatial awareness, VMI, hand-eye coordination, proprioception, spatial awareness & dynamic balance		
Place down a swivel rope and a medicine ball. At the end of the rope there will be a blackboard, cone, colour balls and a Step-n-catch. On the blackboard will be a line through the middle. On the one side of the line will be half shapes drawn. 2m away will be different colour shapes cut out with letters on them. At the other end will be a blackboard with cones drawn on it. On top of the cones will be shapes with letter (same as cut out shapes) drawn. (this represents the ice cream scoops). On the way back will be a pair of stilts. 	*Storyline: We have many customers waiting. Let's scoop the ice cream into the cones.* • Children will roll the medicine ball all along the swivel rope while bear crawling and then complete the picture on the blackboard (like a mirror image) on the other side of the line. • Child will use the cone to catch a colour ball by stepping onto the Step-n-catch and walk towards the cut-out shapes while throwing the ball up and down. • Child will pick up a cut-out shape the same colour as the colour ball and place it on the correct shape on the board (matching the letters and the shapes). • The child will walk back to the start with the stilts. **Progression:** on the way back will be big colour shapes and laminated letters. The child has to then make the ice cream he made on the blackboard using the shapes and letters.	

Activity 2

Extra focuses: Temporal awareness, colour recognition & strength

Layout a twister mat.
On the other side place down ice cream sticks with letters on them as well as 4 ropes in a zig zag.
All along the ropes spread out cut outs of lolly pops (paper circle cut outs) with letters.
On the other side of the ropes will be cut outs of ice cream scoops with words on it (all flavours of ice cream).
There will also be cut outs of big cones with a letter on it.



Storyline: Make sure you give the customers the correct flavours.

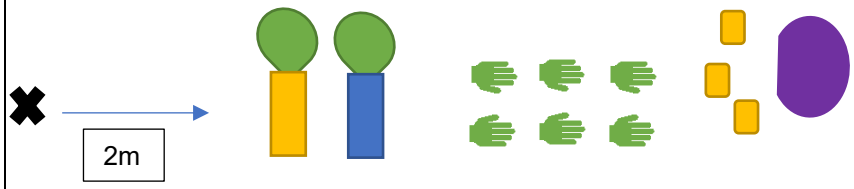
- The child will receive a colour pattern at the start of the activity (for e.g., Blue, green, yellow, yellow, red)
- They will hop on that colour pattern on the twister mat and then pick up an ice cream stick.
- Child will walk heel-toe on the ropes and look for the lollypop with the **same letter** as their ice cream stick and them together.
- At the end of the rope child must pick up an ice-cream scoop the same letter as the lollipop and place the scoop on top of the cone with the same letter.
- Children will crabwalk back to the start.

Progression: hop on 1 leg on the twister mat.
Progression: walk backwards on the ropes.

Activity 3

Extra focuses: Strength, body awareness, hand-eye coordination & spatial awareness

2m away from the start place down 2 colour buckets with a balloon on top of it. Small letters will be spread around it
On the balloon will be small letters written on it.
On the other side will be 3 pairs of tactile hands in front of each other and letter beanbags with a big cut out of an ice cream scoop with letters written on it.



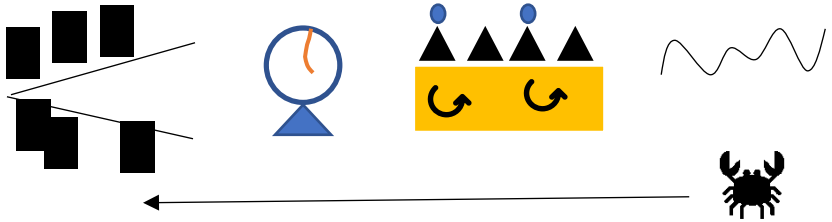
Storyline: Place on all the ice cream toppings to finish off our ice cream cones.

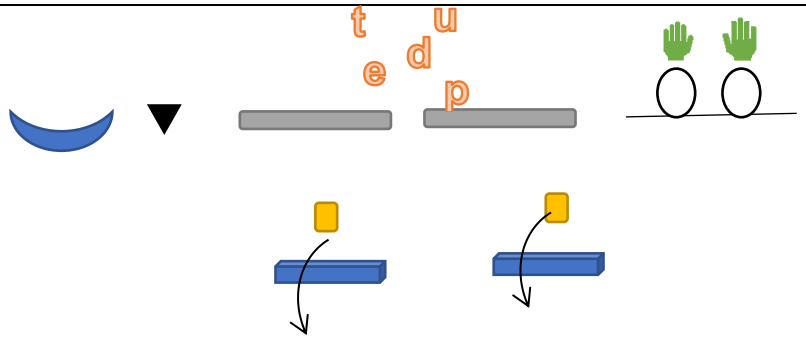
- Children will start by doing turn over plank-crab walks towards the balloons.
- They have pick up 2 letters and stick them onto the correct letter on the balloon.
- The child has to do gymnastic bunny hops on the tactile hands (kick legs up) and then pick up a beanbag and throw it onto the correct letter on the ice cream scoop. The child will sideways criss-cross walk back to the start.

Progression: caterpillar walk to the balloons.
Progression: be in crabwalk position while throwing beanbags.

Cool down **Extra focuses:** Hand-eye coordination		
	Storyline: Pass the ice cream around so that everyone can have some • Children will stand in a circle. • There will be 2 cones, each with a balloon on it. • The children then have to pass the cone around the circle without the balloon falling off.	

WEEK 6 SESSION 11 **Theme:** Sailors		
Main focus: Visual perception & Letter recognition		
Equipment: Poles, cones, letters, blackboard, foam block, beanbags, colour dots, tactile feet, ropes, hula hoops, hula hoop stands, mat, colour balls, tilt board, balance beam & tactile hands		
SET UP	**DESCRIPTION**	**PRESENTER NOTES**
Warm up **Extra focuses:** Directionality & motor planning		
	Storyline: Keep the ship balance to make sure it doesn't tip over. • Children will all stand facing the presenter. • The presenter will shout out directions, and then the children have to run to that direction. • Shout: "Left! Right!, Front!, Back!, Down!, Up!"	
Activity 1 **Extra focuses:** Strength, spatial awareness, static balance, hand-eye coordination, colour recognition & bilateral coordination		
Set up 2 cones with a pole. Place down a letter under the pole. Place down a blackboard with chalk. Place down a foam block with 4 beanbags on the floor around it. Place down 4 colour dots in a row. On the way back place down 10 tactile feet (right foot left foot pattern)	*Storyline: Time to load everything onto the ship.* • Children will bear crawl over the pole and has to remember the letter on the floor. • The child will then draw this letter on the blackboard. • Child will the balance on the foam block on 1 leg, pick up a beanbag and throw one on each colour dot.	

	• Child will then criss-cross walk on the tactile feet back to the start. **Progression:** child will stand on one leg on the foam block **Progression:** place down 2 letters on the floor, child has to write down both letters.	
Activity 2 **Extra focuses:** Spatial awareness, body awareness, strength, bilateral coordination, vestibular stimulation & letter formation		
Layout 2 ropes in a V formation. Place down 4 tactile feet on the outside of each rope. Place down a hula hoop on a stand with a string and letter hanging from it and then a mat. Next to the mat place down 4 cones. Place a colour ball on the 1st and 3rd cone. Place down ropes on the other side of the mat. 	*Storyline: Get the sails ready to start sailing.* • Child will leap over the v ropes, landing on the tactile feet until he reaches the widest end of the V. • Child will then crabwalk through the hoop looking at the letter hanging from it. • Child will then log roll on the mat, moving the colour ball to the beacon next to it. • Child will then form the letter hanging from the hoop using ropes. • Child will crabwalk back to start. **Progression:** child will hop on one leg over the V ropes. **Progression:** child will do a trunk lift every time they put ball onto next beacon.	Presenters should ensure children form the letter correctly with the ropes.
Activity 3 **Extra focuses:** Vestibular stimulation, dynamic & static balance, letter formation, body awareness, laterality & midline crossing		
Place down a tilt board and then a cone with letters in it. Place down 2 blue balance beams with letters on the one side. Place down ropes in a twirl pattern. At each twirl place down a tactile hand. On the way back place down 2 foam blocks with beanbags on the one side.	*Storyline: We have to keep our ship clean and spotless.* • Children will rock on the tilt board 5 times and then pick a letter out of the cone. • Next, child will walk on the balance beam and when he/she reaches the same letter, he/she will draw that letter on the other side of the balance beam on the ground with chalk. **[Child should still draw the letter big, same size as the foam letters].**	

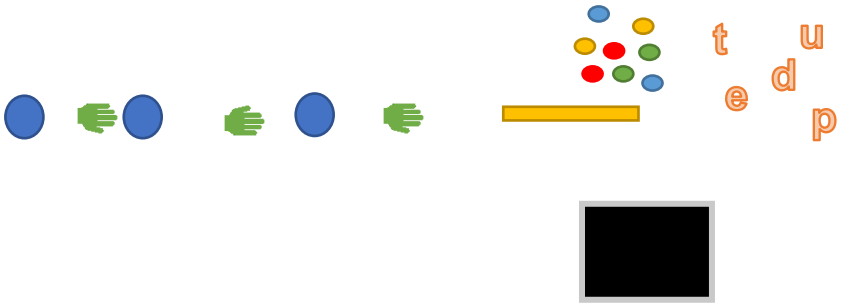
	• Child will then walk on the rope and when he reaches the hand, he will place that hand on the tactile hand. • Child has to hop on the foam blocks and transfer the beanbag from one side to the other using 1 hand. **Progression:** walk backwards on the balance beam and ropes. **Progression:** stand on one leg while picking up and transferring beanbag.	
Cool down **Extra focuses:** Laterality		
Dots will be drawn on the ground in a circle.	*Storyline: Listen closely to your captain.* • Each child will stand on a dot. • They will then listen to instructions and tap with their right/left foot forward/left/right/back.	

WEEK 7 SESSION 12 **Theme:** Rainbow		
Main focus: Directionality		
Equipment: Colour dots, tactile hands, step-n-catch, colour balls, foam letters, blackboard, cones, poles, arrows, tactile feet, ropes, hula hoop, beanbags & twister mat		
SET UP	**DESCRIPTION**	**PRESENTER NOTES**
Warm up **Extra focuses:** Colour recognition		
	Storyline: Look for the rainbow and all its different colours. • A colour dot will be placed on each side (one yellow/green/blue/red). Presenter will stand in front of the children and what colour they have to move to. • Children must keep facing the presenter while moving to that colour.	

Activity 1

Extra focuses: Body awareness, laterality, hand-eye coordination, proprioception, colour recognition & dynamic balance

Place down 3 colour dots in a line in front of each other. (2m apart)
1m in front of each colour dot place down a tactile hand.
Place down a beanbag see saw and colour balls with letters on it.
Spread out different colour paper letters.
Place down a blackboard and draw rainbow stripes on it, each with a different letter at the end.



Storyline: Colour in the rainbow.

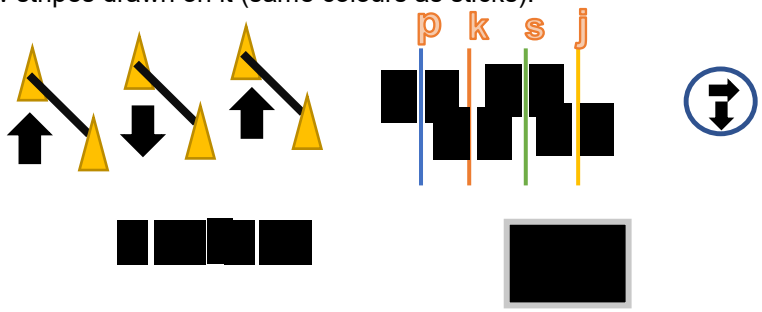
- Children will stand on the colour dot bend down and place hand on the tactile hand. They will then drag that hand from the one side of their body to the other. Repeat with the other tactile hands.
  [This is also to develop midline crossing].
- Child must catch a colour ball using the Step-n-catch and pick up the colour letter shown on the ball they just caught.
- They will stick that colour letter on the correct colour stripe and letter on the blackboard.
- Children will hop on 1 leg back to the start.

Progression: children must be in a plank position while moving hand.
Progression: child will do bunny kicks back to the start. (gymnastics bunny hops).

Activity 2

Extra focuses: Spatial awareness, strength, dynamic balance, colour recognition, bilateral coordination & midline crossing

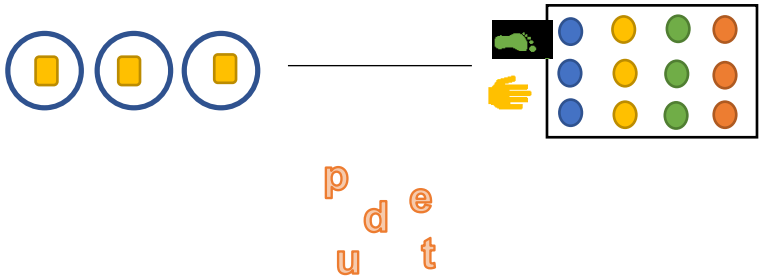
Layout 3 hurdles. Stick an arrow on each hurdle pointing other up or down. Place down 4 different colour ropes next to each other horizontally. There will be tactile feet on either side of each rope and a letter will also be placed on each rope. A hula hoop will be placed down at the other side with 2 arrows inside it and then a blackboard with 4 rainbow stripes drawn on it (same colours as sticks).

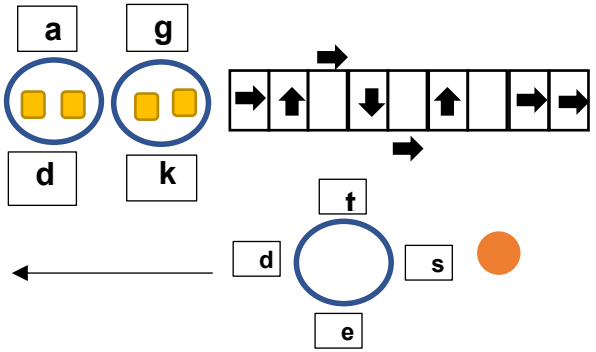


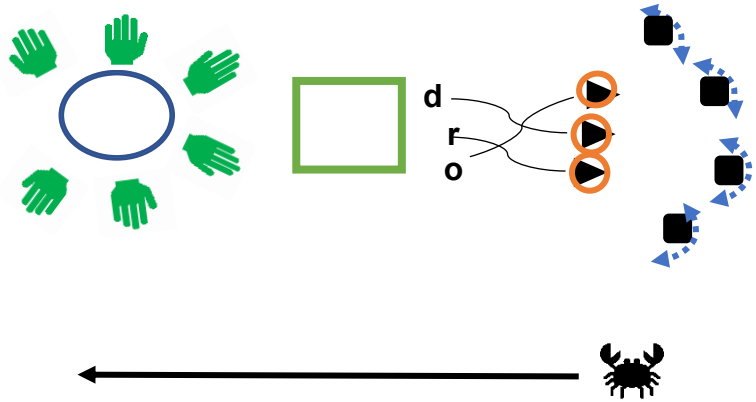
Storyline: Let's look what is under the rainbow.

- Children will follow the arrows on the hurdles by either hopping over or crawling under the hurdles.
- Next, child will hop on the tactile feet, turning his/her body as shown by the tactile feet. Child also has to remember the letter at each colour.
- Child will then stand in a plank position with hands in the centre of the hoop and follow the arrows by moving hands in that direction. (for e.g. Left hand will move upwards, and right hand will move to the right).
  [Child has to be able to coordinate hands separately and in different directions].
- Child will draw what letters he/she saw at each colour stick on the blackboard and sideways criss-cross walk back to the start.

Presenter can change direction and position of tactile feet as well as change the direction of the arrows often.

	Progression: child will hop with one leg over the sticks. **Progression:** child will place feet in the hoop and follow arrow with feet.	
Activity 3 **Extra focuses:** Strength, hand-eye coordination, body awareness, colour recognition & letter recognition		
Place down 3 hula hoops in a line with a letter beanbag in each one. Next place down a rope and then a twister mat with 1 tactile foot and a tactile hand in front of it. Foam letters will be spread out on the way back. 	*Storyline: Let's walk on the rainbow.* • Children will do a burpee in the hula hoop and then throw the beanbag into the next hula hoop. They will then hop into the next hoop, do a burpee and throw beanbag into the third hoop. Once child has hopped into the last hula hoop he will throw the beanbag into the first hoop. • Child will zigzag hop over the rope and plank walk on the twister mat. The hand and foot will show him/her on which colour to place his/her hands and feet. • Child will hop on the foam letters on the way back that are the same letters as the beanbags he/she threw. **Progression:** hop in, left, right, forward, backward in the hula hoop before throwing beanbag. **Progression:** crabwalk on the twister mat.	
Cool down **Extra focuses:** Static balance, flexibility & body awareness		
	Storyline: Let's do some rainbow stretches. • Children will stand in a line and follow the presenter: ○ Stand on toes and reach arms up. ○ Move to the left side, arching body and touching feet. ○ Move back up straight. ○ Move to the right side, arching body and touching feet.	

WEEK 7 SESSION 13 **Theme:** Hot air balloon		
Main focus: Directionality		
Equipment: Hula hoops, letter beanbags, agility ladders, medicine ball, arrows, tactile hands, cones, ring ropes, colour squares, ball, parachute		
SET UP	**DESCRIPTION**	**PRESENTER NOTES**
Warm up **Extra focuses:** Laterality & dynamic balance		
Children will stand in a line facing the presenter and run on the spot.	*Story line: Catch the hot air balloon before it leaves.* • Presenter will point in a direction and children must hop either left/right/up/forward or back.	Note whether children hop in right direction and correct them. Also note whether child hesitates/looks at others first before hopping.
Activity 1 **Extra focuses:** Strength, midline crossing, static & dynamic balance		
Place down 2 hula hoops a line. Place 2 letter beanbags in each one as well as 2 laminated letters on either side of each hoop. Place down an agility ladder with arrows pointing in different directions in and outside the ladder (forming a path). Place down a hula hoop with 4 letters around it and medicine ball.  	*Story line: We are too late for the hot air balloon, so let's make our own.* • Child will start in a sit up position in front of the hula hoops and move the beanbags to its matching letter using only his/her feet. Repeat this for another hoop as well. **[This is to develop core strength and help child recognize and match letters].** • Next, child will hop with 2 feet through the ladder, following the directions. • Child will stand in the last hula hoop and pick up medicine ball, squat down touch a letter with the ball and jump up saying the letter. Repeat for all 4 letters, hopping in a circle as he goes (**anti-clockwise**). • Child will do homolateral walk back to the start. **Progression:** child will do the cross-lateral walk back to the start.	Presenters should note whether children can match letters, or do they get confused with similar letters (such as b and d). They should also observe if children are able to follow the directions of the arrows correctly.

<table>
<tr><th colspan="3">Activity 2
Extra focuses: Strength, body awareness, VMI, laterality & dynamic balance</th></tr>
<tr>
<td>Place down a hula hoop with 6 tactile hands around it (alternating left and right). Place down a colour square and write down 3 letters in a line at the top of the square. Place down 3 small cones with the same letters on them 2 m away from the square. Tie 3 ropes to 3 colour rings and place the down randomly. On the other side of the cone, place down a half moon of 4 beanbags.
 
</td>
<td>Story line: Time to take off in our hot air balloon and do some sight seeing

• Children will start in a plank position in the hula hoop (feet inside hoop and hands on the tactile hands). They will move around the hoop by going form plank to crab walk until they reach the beginning again.
• Move in an anti-clockwise direction. [This is to teach children the correct direction a letter is written (top-bottom, left-right, and anti-clockwise].
• Child will walk to the square and will pick up a rope and place it from the one letter on the cone to its matching letter on the square (placing the ring on the cone). [This is to help child recognize and match the same letter and to teach the correct direction of writing (top-bottom)].
• Child will hop onto the beanbag, hop to the left of the beanbag, then the right and then onto the next beanbag. Repeat for the other beanbags and crabwalk back to the start.

Progression: when child connected the one letter to the other using the rope, child has to say a word starting with that letter.
Progression: child will hop on the beanbags backwards (still hopping left & right over each one).</td>
<td>Pay specific attention to the children’s core strength in this activity and ensure they perform the activity properly. Note whether children remember what side to hop to on the beanbags and can match certain letters.</td>
</tr>
<tr><th colspan="3">Activity 3
Extra focuses: Spatial awareness, VMI, laterality, letter recognition, dynamic balance & midline crossing</th></tr>
<tr>
<td>Draw different types of lines on the ground (swivel/zig-zag/loops) and place down ropes on the side.
Place down an agility ladder and draw a b/d in each block.
On the way back place down 3 colour squares and a ball and draw an figire-8 sign on the ground.</td>
<td>Story line: Time to land our hot air balloon

• Child will place a rope exactly on the drawn line and then walk heel-toe on the rope.</td>
<td>Presenters note if children get confused between the b’s and d’s and assist children if they struggle to cross the middle at the figure-8 drawing.</td>
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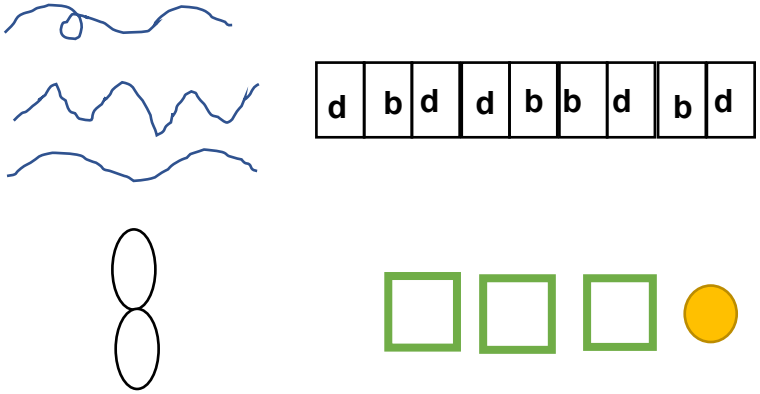
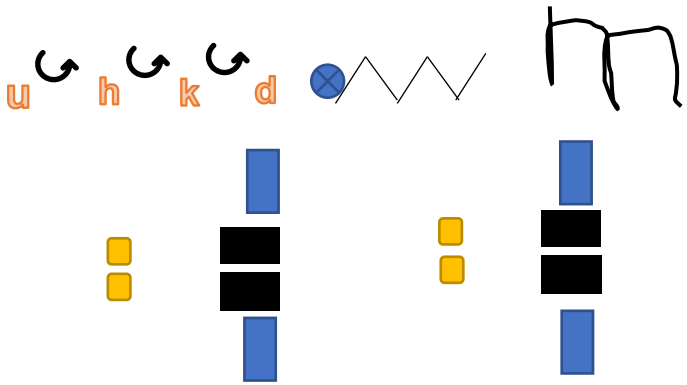
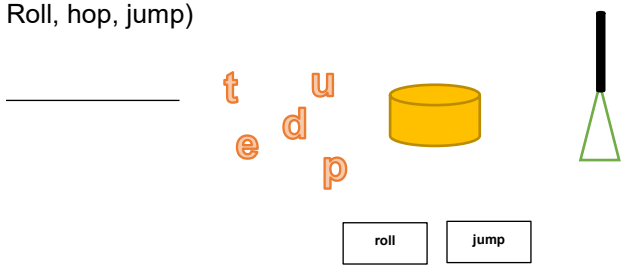
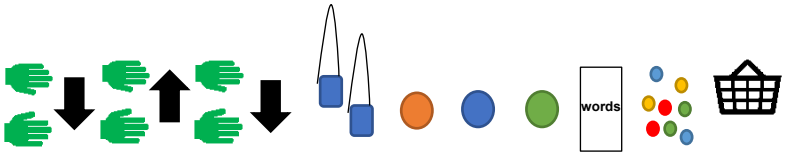
	**[This is to help child learn to write inside the lines and to teach spatial awareness].** • Child will be instructed to hop either on all the b's or all the d's through the agility ladder with 2 feet. • Child will hop onto the colour squares on 1 leg, bounce the ball and hop to the next square. • Child will bear walk on the figure-8 sign. **Progression:** draw b's and d's outside the ladder as well. Child must hop on them as well. **Progression:** stick a letter onto a wall in front of the figure-8 sign. Child will walk heel-toe on the figure-8 while looking and reading the letter in front of him.	Presenters should also ensure child walks on the figure-8 sign in the same direction as one would write it. This is to ensure child crossed the midline which is an important skill for handwriting.
Cool down **Extra focuses:** Body awareness & vestibular stimulation		
Children will lie on the ground looking up to the sky while presenters hold a parachute over them.	*Story line: Look at all the beautiful colours of the hot air balloon.* • Presenters will walk in a circle while waving the parachute up and down slowly. • Children will then be instructed to lift a specific limb up to the parachute (left/right arm/leg). • At the end, presenters will bring down the parachute and catch the children in it.	Note which children struggle to know which limb to lift and if the lift the wrong side.

WEEK 8 SESSION 14 **Theme:** Grocery shopping		
Main focus: Visual perception		
Equipment: Foam letters, medicine ball, rope, colour buckets, tactile feet, beanbags, stepping stone, cone, pole, action words, tactile hands, arrows, stilts, colour dots, colour balls & baskets		
SET UP	**DESCRIPTION**	**PRESENTER NOTES**
Warm up **Extra focuses:** Laterality		

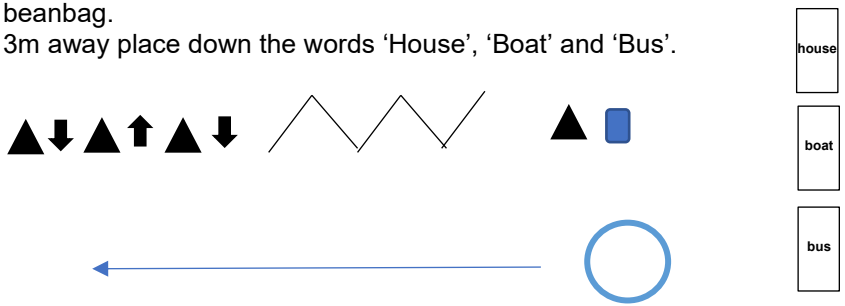
	Storyline: Follow the right directions to get to the grocery store.
	
	• Children will stand in 4 lines. 5m away from each line will be a hula hoop with an arrow.
	• The child will run to the hoop and follow the direction of the arrow:
	  ○ Left/right: place hands on hoop as if holding a steering wheel and run around it either clockwise or anti-clockwise.
	  ○ Up: Do a frog jump over the hoop.
		Presenters should change direction of arrow often and ensure children follow directions correctly.

Activity 1 **Extra focuses:** Strength, vestibular stimulation, dynamic balance, spatial awareness & letter recognition		
Place down 4 foam letters in a line, each 1m apart. Place down 4 ropes in a zig zag with a medicine ball. Form a big letter using rope and place it on other side of ropes. On the way back place down 2 sets of tactile feet with buckets on either side of them. Stick letters onto buckets. Place two letter beanbags 1m in front of each pair of feet. 	*Storyline: Try to navigate your way through all the aisles.* • Children will plank walk in front of the letters. When child reaches a letter, he has to do a push up and say what letter he saw. In between each letter child will log roll and go back into a plank. • Child will roll a medicine ball on the rope while walking like a bear and crab walk along the letter. **[Note: child must move in the correct direction. Move as if he is drawing the letter, e.g. Top-down, anti-clockwise.]** • Child will stand on the tactile feet, caterpillar walk forward to get the beanbags and place the beanbags into the correct bucket. **Progression:** draw the letters a bit bigger with chalk on the ground. Child will then be in a plank while tracing the letter using his hands. **Progression:** child will stand on one leg on tactile foot, bend down and pick up the beanbag to place into basket.	Presenters should assist child in 'tracing' the letter correctly (in correct direction).
Activity 2 **Extra focuses:** Dynamic balance, spatial awareness, sight-word recognition & strength		
Place down a rope. Spread out letters on the floor and then place down a stepping stone. Place a pole into a cone with letters stuck onto the pole.	*Storyline: Pack everything back onto the shelves.*	Before the activity ask children to read out every action word as well as

On the way back place down 6 papers with a one-word activity written on it. (eg. Roll, hop, jump) 	• Children will walk heel-toe backwards on the rope, pick up a letter on the floor and stand on the stepping stone to stick the letter onto the same letter on the pole. • Child will run to each paper and complete the activity on the paper. **Progression:** place down beanbags on one side of the rope. Child will move beanbags over to the other side using only one hand while walking heel-toe backwards.	demonstrate the action that goes with it to ensure children know what the word is.
Activity 3 **Extra focuses:** Strength, directionality, dynamic balance, spelling & counting		
Place down 3 sets of tactile hands in front of each other with an arrow at each pair. Place down a pair of stilts and a row of colour dots. Place down a stack of words (can be any words) and colour balls and then a basket 1m away. 	*Storyline: Time to pay for all our groceries.* • Child will place hands on tactile hands and then kick legs out in direction shown by the arrow. • Child will walk on the stilts in between the colour dots and then pick up a word. • Child has to the throw the same amount of colour balls into the basket as the number of letters in the word they picked up. (e.g. Cat: throw 3 balls into basket). **[Note: Child has to spell out each word as he throws the balls].** • Child will crabwalk back to the start. **Progression:** letters will be placed down instead of colour dots. Child has to say the letter out loud as he passes it as well as a word that begins with that letter. **Progression:** child will throw ball under through legs.	
Cool down **Extra focuses:** Laterality & body awareness		
	Storyline: Time to drive home. • Children will pair up with someone and sit opposite each other. • One child will be the leader and the other child has to follow the leader's movements and move in the same direction.	

WEEK 9 SESSION 15 **Theme:** Cars		
Main focus: Letter recognition		
Equipment: Cones, arrows, colour cards, ropes, beanbags hula hoops, action words, medicine ball, hockey stick, colour balls, ball, foam letters, twister mat & playdough		
SET UP	**DESCRIPTION**	**PRESENTER NOTES**
Warm up **Extra focuses:** Colour recognition, vestibular stimulation & directionality		

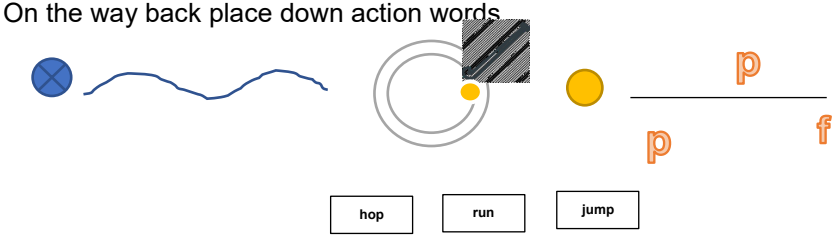
	Storyline: Read the directions carefully while driving your car.
	
	• Children will all stand facing the presenter and start running towards the presenter.
	• The presenter will hold up cards and the children will then follow the instructions on the card.
	  ○ Red: stop in place.
	  ○ Orange: walk slowly.
	  ○ Green: run.
	  ○ Left/Right: run in that direction.	

Activity 1 **Extra focuses:** Spatial awareness, dynamic balance, hand-eye coordination, VMI & bilateral coordination		
Place down 3 cones in a line with an arrow at each cone Place down 4 ropes in a zig zag pattern. Place down a picture of a house, boat, and bus under a cone with a beanbag. 3m away place down the words ‘House’, ‘Boat’ and ‘Bus’. 	*Storyline: Navigate your car to get to our destination* • Children will run towards and around the cones, following the direction of the arrows and then walk on the ropes. • Children will pick up the cone and throw the beanbag onto the word that matches the picture under the cone. • Children will skip with a hula hoop back to the start. **Progression:** run backwards between the cones. **Progression:** write down word on a blackboard on the way back.	

Activity 2

Extra focuses: Spatial awareness, hand-eye coordination, strength & dynamic balance

Draw a swivel line with chalk on the ground and place down a medicine ball.
Draw a double line letter on the floor with chalk and pace down a hockey stick and tennis ball.
Place down a rope with 3 foam letters on the sides and a ball.
On the way back place down action words.



Storyline: Make sure you stay in the road while you drive.

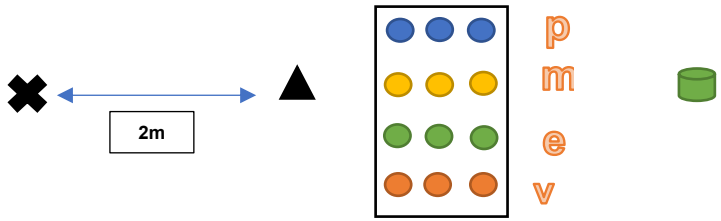
- Children will roll the medicine ball on the swivel line while bear crawling and dribble the tennis ball with the hockey stick through the letter (as if writing letter). **[Child should trace letter in the correct direction].**
- Next, they will walk heel-toe on the rope and bounce the ball onto each letter and say that letter out loud.
- Children will perform the movement of the action words on the way back.

Progression: walk heel-toe in the letter.
Progression: hold medicine ball above head while waling heel-toe on swivel line.

Activity 3

Extra focuses: Cross-lateral coordination, colour recognition, tactile stimulation, letter formation, motor planning & bilateral coordination

2m away from starting point, place down a cone with words of different colours under it. (red, green, yellow, blue).
Place down a twister mat and a letter and at the end of each row of colours.
Place down play dough.



Storyline: Look carefully at the traffic light colours before driving.

- Children will cross lateral walk towards the cone and read what colour is under the cone.
- They must hop on those colour dots on the twister mat and then make the letter that is at the end of their colour row out of playdough. **[If child struggles, this can also be done on a laminated letter, child will then form letter with playdough on the laminated paper, using it as a guide].**
- Child will caterpillar walk back to the start.

Progression: squat jump towards the cone.
Progression: hop on 1 leg on colour dots.

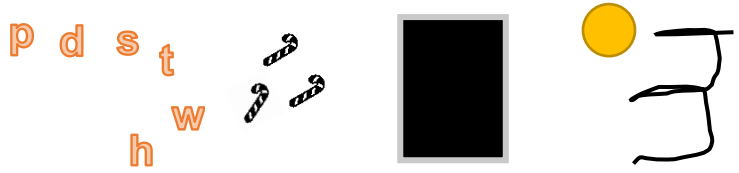
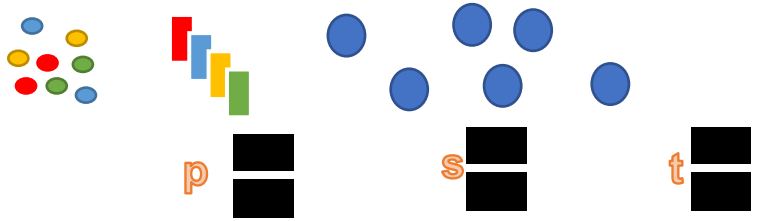
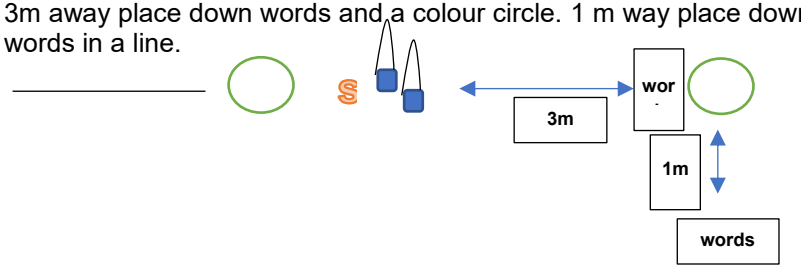
Presenters can show children the colour words at the start of the activity and help them read it to ensure they know the word.

Cool down **Extra focuses:** Directionality		
	Storyline: In traffic on the way home. • Children will sit in one long line, holding onto each other's shoulders. • The front person will then lean to one side and the whole line has to follow in the direction he is leaning.	Encourage children to go faster and slower.

WEEK 10 SESSION 16 **Theme:** Candyland		
Main focus: Spelling and Bilateral coordination		
Equipment: Action words, foam letters, candy cane pictures, blackboard, ball, ropes, colour balls, colour buckets, colour dots, tactile feet, hula hoop & stilts		
SET UP	**DESCRIPTION**	**PRESENTER NOTES**
Warm up **Extra focuses:** Vestibular stimulation		

	Storyline: Pop like popcorn.
	
	• Children will run in a circle.
	• Presenter will hold up a word and children have to complete the action of the word.
	  ○ Run: keep running in a circle.
	  ○ Pop: jump up high in the air.	

Activity 1 **Extra focuses:** Strength, letter recognition, letter formation & hand-eye coordination		
Place down letters in the shape of a candy cane. Place down pictures of candy canes with letters on them and place down a blackboard. Place down a rope in the shape of a letter with a ball.	*Storyline: Candy cane* • Children will ski jump over the candy cane and say out the letters as the go. • Presenter will then show child a word and child have to crab walk and collect the candy cane letters to spell that word on the blackboard (sticking letter on) (Appendix H: Image 13).	

	• Child will roll the ball on the rope letter and say out what letter is on the floor. **[Child should trace letter in the correct direction].** **Progression:** place down letters to form a word (in candy cane shape). **Progression:** child will bounce ball on the rope.	
Activity 2 **Extra focuses:** Cross-lateral coordination, colour recognition, letter recognition & spatial awareness		
Spread out colour balls and stick letters on each of them. Place down 4 colour buckets with a letter on each of them. Spread out colour dots randomly with letters on them. On the way back place down 3 sets of tactile feet. In between each set place down a letter. 	*Storyline: Smarties.* • Child will cross lateral walk and pick up 2 colour balls and throw them into the correct cone that has the same letter on. • Child will be shown a word and has to spell that word by hopping on the letters on the colour dots. • On the way back child will stand on the tactile feet and hop over to the next pair saying out the letter he/she jumped over. **Progression:** child will plank walk while collecting colour balls and stay in that position while throwing balls into cones. **Progression:** child will bounce ball on the colour dots to spell the word.	Presenters can assist children that struggles to spell the words by calling out the letters in the correct order. Ask child to complete it by himself afterwards.
Activity 3 **Extra focuses:** Spatial awareness, strength, dynamic balance, VMI, cross-lateral coordination & hand-eye coordination		
Place down a rope and a colour circle at the end of it. Place down a letter on the other side of the circle. Place down a pair of stilts. 3m away place down words and a colour circle. 1 m way place down words in a line. 	*Storyline: Lollipops* • Child will walk heel-toe on the rope. When he/she reaches the circle, he will keep feet in the circle and plank walk with hands around the circle. Child has to say the letter out loud when he/she moves over it. • Child will walk on stilts towards the words to collect a word and throw the colour circle over the same word 1m away. • Child will criss-cross hop on the way back.	

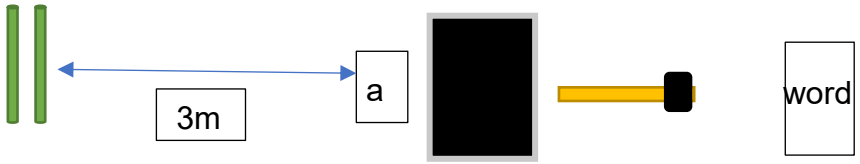
	Progression: walk heel-toe backwards on the rope. **Progression:** child will be in a plank position while throwing circle.	
Cool down **Extra focuses:** Flexibility & body awareness		
	Storyline: Stretch like fizzers. • Children will sit in a circle with legs straight in front of them. • They will the stretch hands towards toes and then move up again, arms straight in the air. • They will then lie on their back and stretch body out straight. • Repeat a few times.	

WEEK 10 SESSION 17 **Theme:** Hiking		
Main focus: Letter sounds & Bilateral coordination		
Equipment: Poles, blackboards, step-n-catch, beanbags, medicine ball, ropes, blocks, hula hoops, tactile feet, colour balls, colour buckets,		
SET UP	**DESCRIPTION**	**PRESENTER NOTES**
Warm up **Extra focuses:** Letter recognition & VMI		
	Storyline: Look closely at the directions to know where to we are hiking. • Presenters will hold up pictures of letters (vowels). • If it is a single vowel sound (e.g., a/e/o/u/i), then the children will hop forward once. • If it is a double vowel sound (e.g., aa/ee/oo/uu/ou) the children will hop forward twice while making the sound of the double vowel.	

Activity 1

Extra focuses: Letter recognition & formation, hand-eye coordination, proprioception & dynamic balance

At the start of the activity sticks down 2 poles.
3m away place down pictures of double vowels (aa/uu/oo/ee) and a blackboard.
On the other side of the blackboard place down a Step-n-catch and a beanbag.
Spread out words with single and double vowels (e.g. See/saw/look/lock).



Storyline: Hiking up the mountain

- Children will homolateral walk with the poles (lifting up same side arm and leg high).
- The presenter will then show them the picture of the double vowels sounds.
  [It is important that children know the sound these double vowels make]
- The child has to say what sound it makes and then write it down on the blackboard.
- The child will then catch a beanbag with the seesaw and throw it onto a word that has the same sound in it (also saying the word out loud).
- Child can then hop on 1 leg back to the start.

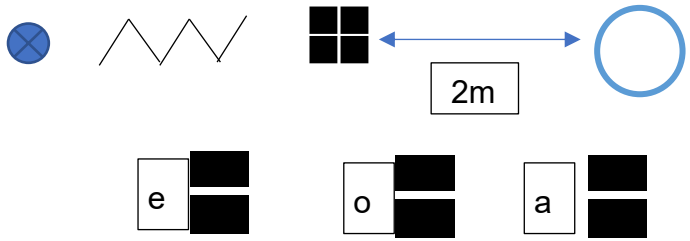
Progression: child will cross lateral walk with the poles.
Progression: child has to write down a word that has the double vowel sound on the blackboard.

Presenters can show every double vowel sound to child at start of activity and ask children to repeat the sounds.

Activity 2

Extra focuses: Spatial awareness, letter recognition & dynamic balance

Place down a medicine ball and a zig zag rope (or zig zag drawn on floor).
Spread out blocks with words on them (double vowels).
2 m away place down a hula hoop and on the way back place down 3 sets of tactile feet. In between each pair place down a double vowel sound picture.

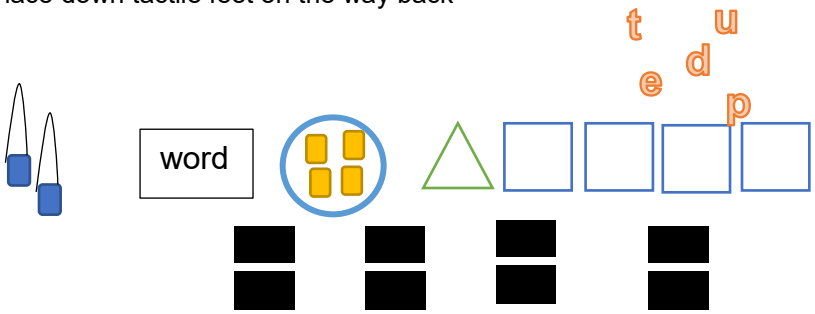


Storyline: Making a fire.

- Child will bear walk while pushing the medicine ball on the zig zag line.
- Child will then be shown a double vowel sound picture.
- Child then has to look for word on blocks that has that sound and crab walk to the hula hoop.
  [Child must be able to identify the double vowel sounds in a word].
- Child will place down block in the hoop and walk heel-toe around the hoop. (also say word out loud)
- Child will hop on tactile feet on the way back, saying the sound that is on the floor.

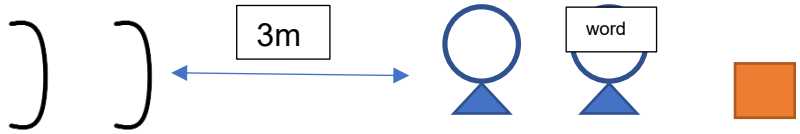
Progression: Walk backward on zig zag line while holding medicine ball above head.

Activity 3 **Extra focuses:** Dynamic balance, letter recognition & spatial awareness		
2m away from starting point place down a blackboard with double vowel sounds on it. On the other side, lace down a rope and spread out colour balls around it. 2m away place down a row of 4 colour buckets with double vowel sounds on each one. On the way back place down a hula hoop.  	*Storyline: Packing our bags* • Children will receive a double vowel sound word and hop on one leg to the blackboard and stick it on the correct sound. • Children will walk heel-toe on the rope, pick up a ball and throw it into a colour bucket with the same vowel sound as the word they received previously. • They will skip with the hula hoop back to start. **Progression:** criss-cross hop to the blackboard. **Progression:** plank walk over the rope.	
Cool down **Extra focuses:** Hand-eye coordination, flexibility & body awareness		
	Storyline: Campfire story. • Children will sit in a circle with legs out in v formation. • They will then roll colour balls (5-6) between each other, preventing them from escaping the circle.	

WEEK 11 SESSION 18 **Theme:** Going to the beach		
Main focus: Spatial awareness & Spelling		
Equipment: Stilts, hula hoops, shapes, beanbags, tactile feet, foam letters, colour dots, colour buckets, colour balls, ropes, beacons, hula hoop stands, hurdles & sand tray		
SET UP	**DESCRIPTION**	**PRESENTER NOTES**
Warm up **Extra focuses:** Number recognition		
	Storyline: Get in the car to go to the beach. • Children will each be assigned a number from 1-4. • They will run in a circle and when the presenter calls out their number, everyone that has that number has to run to the middle, touch the floor and run back to the circle.	
Activity 1 **Extra focuses:** Dynamic balance, strength, letter recognition & bilateral coordination		
Place down stilts and a row of words. Place down a hula hoop with 4 letter beanbags in it. Place down a triangle and 4 squares in a row. Place down foam letters. Place down tactile feet on the way back 	*Storyline: Building a sand-castle.* • Children will walk on stilts while stepping over each word (saying the word as they go). • Child will stand in a plank position at the circle and move beanbags out of the circle using both hands also saying the letters). • Child will receive a word from the presenter and has to spell the word by placing the letters in the triangle and squares. • Child will hop on tactile feet back to the start **Progression:** child will move the beanbags out of the circle using feet. **Progression:** hop on 1 leg on tactile feet.	Presenters should observe if children can place letters in the correct order. If not, presenter should ask child to look at the word again and see if letters are in same order and retry.

<table>
<tr><th colspan="3">Activity 2
Extra focuses: Letter recognition, dynamic balance & cross-lateral coordination</th></tr>
<tr><td>Spread out colour dots with letters on them.
Layout a colour bucket and swivel rope and spread out colour balls with letters on them around the rope.
Place down a row of 5 beacons.
  </td><td>Storyline: Collecting shells

• Children will receive a word at the start of the activity and have to spell the word by hopping on the colour dots.
• Child will walk heel-toe on the rope and collect the colour balls with letters of their previous word, placing them in the bucket.
• Child will place the colour balls on the beacons to spell out their word and cross lateral walk back to the start.

Progression: walk backwards on the rope.
Progression: criss-cross hop back to the start.</td><td>Presenters should observe if children can place letters in the correct order. If not, presenter should ask child to look at the word again and see if letters are in same order and retry.</td></tr>
<tr><th colspan="3">Activity 3
Extra focuses: Strength, tactile stimulation, letter formation & dynamic balance</th></tr>
<tr><td>Place down 2 hurdles, 1m apart.
3m away place down 2 hula hoops on stands.
In the last hula hoop stick a word.
On the other end place down a sand tray.
  </td><td>Storyline: Swimming through the waves.

• Child will bear walk over the hurdles and then crab walk to and through the hula hoops.
• Child must remember the word in the hula hoop and write it in the sand tray.
• Child will hop on 1 leg back to the start.

Progression: hop over hurdle on 1 leg
Progression: do plank to crab walk from hurdles to the hula hoops</td><td></td></tr>
<tr><th colspan="3">Cool down
Extra focuses: Laterality & body awareness</th></tr>
<tr><td></td><td>Storyline: Copy the waves

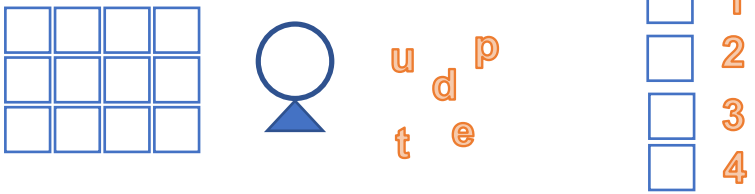
• Presenter will do wave like movements and children have too copy moves.</td><td>Observe if children move in correct direction, correct if wrong.</td></tr>
</table>

WEEK 11 SESSION 19 **Theme:** Baking		
Main focus: Spatial awareness & Spelling		
Equipment: Tactile feet, words, ropes, blackboard, squares, hula hoop, hula hoop stands, foam letters, numbers, parachute, sounds & colour bucket		
SET UP	**DESCRIPTION**	**PRESENTER NOTES**
Warm up **Extra focuses:** Vestibular stimulation & dynamic balance		
6 ropes will be laid out parallel to each other.	*Storyline: Shopping for ingredients.* • Children will stand in one line and has to run between all the ropes (running through each aisle).	
Activity 1 **Extra focuses:** Dynamic balance, letter recognition, midline crossing, letter formation & cross-lateral coordination		
Pack out 4 pairs of tactile feet facing sideways. In front of the last pair place down a word with an arrow on the wall (at child's eye level) On the other side layout a word made out of ropes. Place a blackboard on the other side of the rope. 	*Storyline: Reading the recipe.* • Children will hop on the tactile feet. • When they get to the last pair, they have read out the word while tracing the arrow underneath it. They then have to write each letter individually in the air and read out the word aloud again. *(Instructor can change word often).* • Child will heel-toe walk on the rope word and tell the presenter what the word is and write it on the blackboard. • Child will cross lateral walk on the way back. **Progression:** turn feet in any direction. Children have to turn in that direction as they hop. **Progression:** child has to make the word (on the wall) using the rope and then walk heel-toe on it.	

Activity 2

Extra focuses: Letter recognition, dynamic balance, strength, number recognition & bilateral coordination

Layout 12 squares (3 in a row) and place different double vowel sounds in them (ou/oe/oo/uu/aa/ee).
Place down a hula hoop on a stand on the other side of the squares.
Spread out foam letters and then place 4 squares in a line (number them 1-4).



Storyline: Throwing in the ingredients

- Instructor will give child a sound (ou/oe/oo/uu/aa/ee) and child has to hop on those sounds only to get to the other side of the hopscotch squares.
- Child will crabwalk through the hula hoop stand.
- Instructor will show child a 4-letter word (each letter numbered 1-4) and ask child to read the word and then give child a number.
- Child then has to search for that number's letter and place it into the correct numbered colour square.
- Child will caterpillar walk back to the start.

Progression: child has to hop on all the sounds in the hopscotch blocks to and say the sounds out loud while hopping.
Progression: child must lace all the letters of the word onto the colour squares.

Activity 3

Extra focuses: Bilateral coordination, strength, letter recognition & dynamic balance

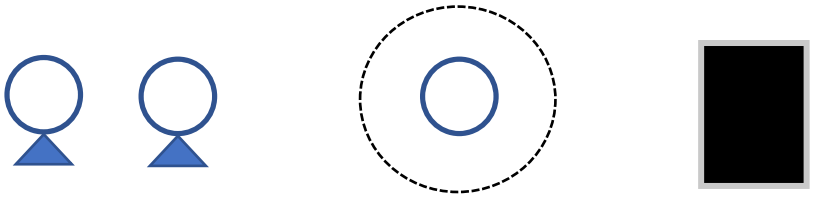
Place down 2 ropes in a v formation.
Place down a pair of tactile feet and 1m away place down a colour bucket with words in it.
Lay out a parachute and assign a double vowel sound to each colour.

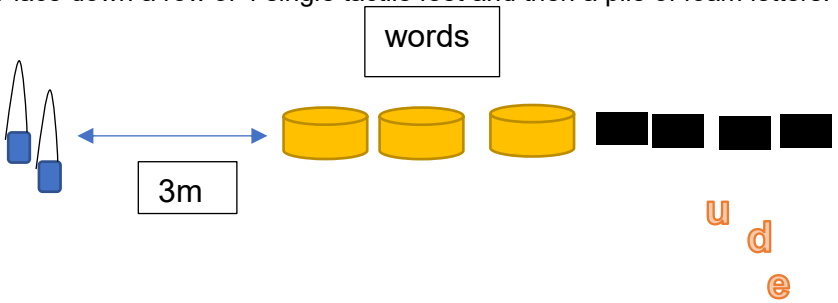
Storyline: Decorating the cupcakes.

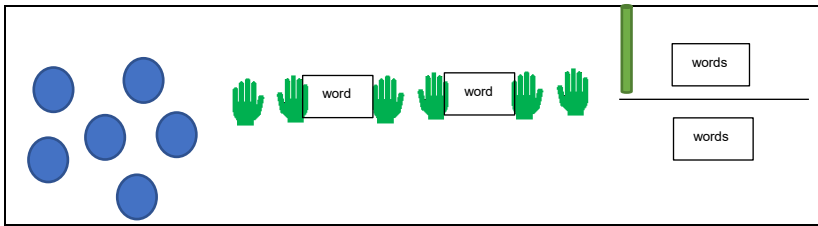
- Child will ski hop (same sides synchronised) over the V.
- Child will stand on the tactile feet, walk forward on their hands and collect a word in the colour cone.
- Child must crab walk to the parachute and place the word on the colour representing the same sound as found in the word.
- Child will hop back on 1 leg.

Progression: place a letter in the middle of the V, child has to say a word starting with that letter as he jumps.
Progression: children will bear crawl backwards back to the start.

Cool down **Extra focuses:** Directionality & vestibular stimulation		
	Storyline: Cool down the cupcakes. • Children will sit in a circle holding the parachute and move it up and down, as the presenter instructs them.	

WEEK 12 SESSION 20 **Theme:** Circus		
Main focus: Spatial awareness & Spelling		
Equipment: Hula hoops, hula hoops stands, blackboard, words, stilts, stepping stones, tactile feet, foam letters, colour dots, tactile feet, pole, ropes & arrows		
SET UP	**DESCRIPTION**	**PRESENTER NOTES**
Warm up **Extra focuses:** Body awareness, directionality & midline crossing		
	Storyline: Fat clowns. • Children will stand in a line facing the presenter. • The presenter will hold up a b/d/p/q. • The children have to then form that letter using their bodies and arms.	
Activity 1 **Extra focuses:** Strength, directionality, letter recognition & formation & dynamic balance		
Set out 2 hoops on hula hoop stands and then a circle of words with a hoop. 2m away place down a blackboard. 	*Storyline: Jumping through the hoops of fire.* • Child will bear crawl backwards through the hula hoops and then stand in the middle of the circle of words and hold the hula hoop • The presenter will hold up an arrow pointing in a direction of one of the words. • Child must place hula hoop over that word and do a gymnastics bunny hop. • Continue until child has hopped over each word.	

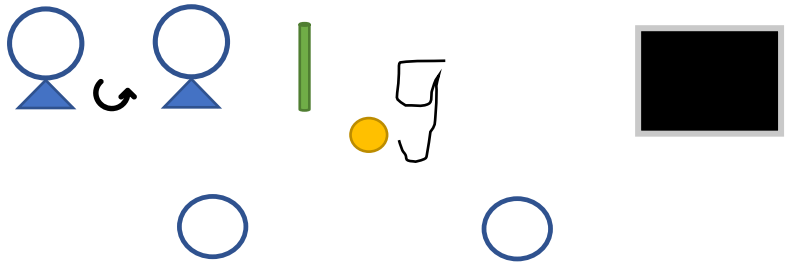
	• Presenter will tell child which of those words he will write on the blackboard. • Child will hop on one leg to the blackboard and write down the word. **Progression:** child will crabwalk backwards through the hula hoops. **Progression:** child will shuffle between the words in the direction the presenter shows. Saying out each word as he reaches it.	
Activity 2 **Extra focuses:** Dynamic balance, body awareness, directionality & bilateral coordination		
Place down stilts and a row of 3 stepping stones 3m away. Stick a word on the wall in front of each colour rock. Place down a row of 4 single tactile feet and then a pile of foam letters.  	*Storyline: Balancing act.* • Child will walk on stilts towards the colour rocks and then hop onto each rock, reading the words on the wall. • Child will hop on 1 leg on the tactile feet. • When child reaches the foam letter, he/she form the letter they see with their bodies. • Child will caterpillar walk back to start. **Progression:** hop on 1 leg on colour rocks. **Progression:** child has to freeze in position while on tactile foot before hopping on the next foot.	
Activity 3 **Extra focuses:** Letter recognition, strength, dynamic balance & bilateral coordination		
Layout 6 colour dots with double vowels on them. Layout a row of 6 tactile hands, placing a word in between each pair. Place down a rope with words on either side. Place down pole next to rope.	*Storyline: Crazy Clowns.* • Child will be told which vowel sounds to hop on. • Child will walk on the tactile hands with hands going from plank position into crab position, reading each word on the floor. • Child has to hold a pole sideways while walking heel-toe on the rope.	

	• Every time he/she reaches a word, the child will lean to that side, placing pole on word and read it aloud. • Child will bear crawl backwards to the start. **Progression:** hop on 1 leg on colour dots. **Progression:** every time child is in plank position, child has to hop with legs in and out.	
Cool down **Extra focuses:** Strength, directionality & vestibular stimulation		
	Storyline: Get into the clown car. • Children will walk in a circle. • When presenter shows a down arrow, children go down into a crouch position and walk like ducks.	

WEEK 12 SESSION 21 **Theme:** Zoo		
Main focus: Spelling awareness & Spelling		
Equipment: Ropes, tactile feet, colour balls, blackboard, hula hoops, hula hoop stands, pole, ball, tactile hands, foam letters, stepping stones & parachute		
SET UP	**DESCRIPTION**	**PRESENTER NOTES**
Warm up **Extra focuses:** Strength, bilateral coordination & letter recognition		
	Storyline: Walk like a… • Children will stand facing presenter. • There will be letters in a circle around them. • The presenter will tell them to walk like a certain animal. • Children will then walk like that animal to the letter it starts with.	

<table>
<tr><th colspan="3">Activity 1
Extra focuses: Strength, bilateral coordination, hand-eye coordination, letter recognition & letter formation</th></tr>
<tr><td>Layout a rope with a pair of tactile feet at the end.
Spread out colour balls a few meters away with letter on them.
Place down a blackboard on the way back.
  </td><td>Storyline: Monkeys are looking for their bananas.

• Children will bear walk on the rope and then stand on the tactile feet, walk forward with their hands and get a ball.
• They must walk to the blackboard while throwing the ball from one hand to the other.
• Child will then write that letter big on the board.

Progression: bear walk backwards on the rope
Progression: write a word starting with the letter they picked.</td><td></td></tr>
<tr><th colspan="3">Activity 2
Extra focuses: Bilateral coordination, hand-eye coordination, letter recognition, letter formation & vestibular stimulation</th></tr>
<tr><td>Place down 2 hula hoops on stands.
Write down big letters on the floor and place down a pole and ball.
Place down a blackboard.
Place down 2 hula hoops on the way back.
  </td><td>Storyline: What does the Tiger’s stripes mean.

• Child will crawl through hula hoops and logroll in between them.
• Child will dribble the ball on the letter with the pole and write down a word starting with that letter.
• Child will run back to start making a 360 turn when at the circles.

Progression: crab walk through the hula hoops.
Progression: hop on 1 leg around circles.</td><td></td></tr>
<tr><th colspan="3">Activity 3
Extra focuses: Tactile stimulation, strength, letter recognition, dynamic balance, body awareness, laterality, static balance & directionality</th></tr>
<tr><td>Layout 4 pairs of tactile hands in a circle with a letter in between each pair.
Layout 3 stepping stones in a line.</td><td>Storyline: Act like a bird.

• Children will place hands on the tactile hands, do a bunny hop and read out the letter, going around in the circle.</td><td></td></tr>
</table>

	• Child will hop onto colour rock, stand on one leg and has to form a letter with their body that will be shown to them. • Child will caterpillar walk back to start. **Progression:** child has to say a word starting with that letter **Progression:** child will froggy jump over the colour rocks and form the letter at the end of the last colour rock	
Cool down **Extra focuses:** Vestibular stimulation		
	Storyline: Closing time. • Children will lie on their back in a circle while presenters move parachute over them.	

APPENDIX I

INTERVENTION IMAGES

Week 1 Session 1 images

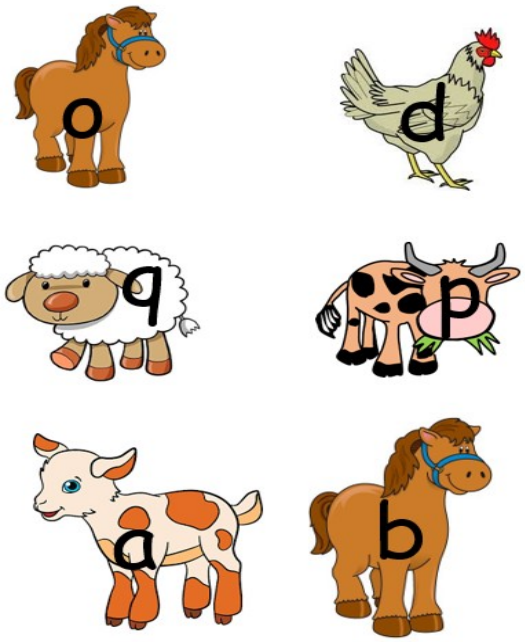


IMAGE 1: **WARM UP**

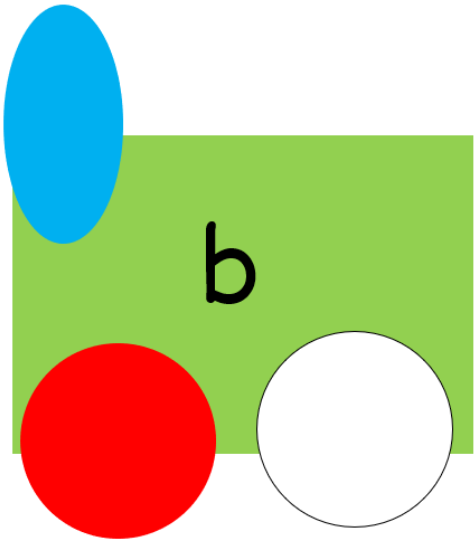


IMAGE 2: **ACTIVITY 2**

Week 3 Session 4 images:

h			p
	b		

IMAGE 3: **ACTIVITY 1**

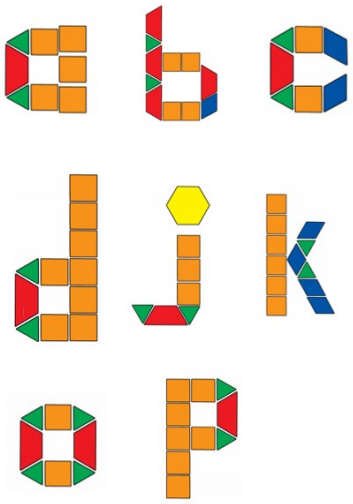


IMAGE 4: **ACTIVITY 2**

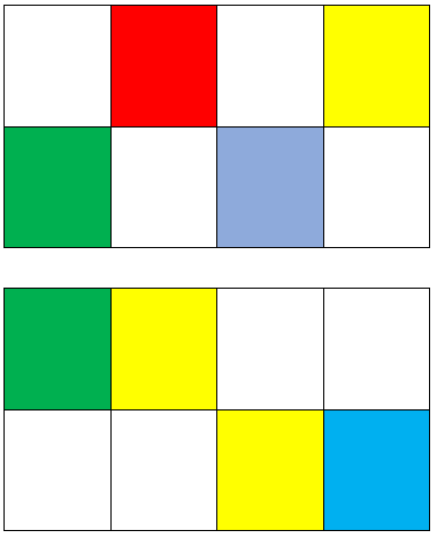


IMAGE 5: **ACTIVITY 3**

Week 3 Session 5 images:

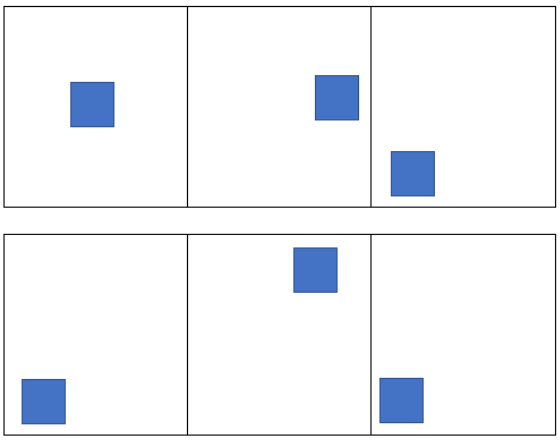


IMAGE 6: **ACTIVITY 1**

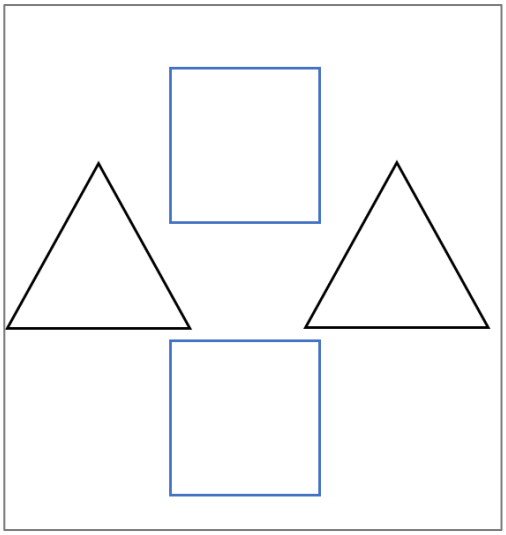


IMAGE 7: **ACTIVITY 3**

Week 4 Session 6 images:

IMAGE 8: **ACTIVITY 2**

Week 5 Session 8 images:

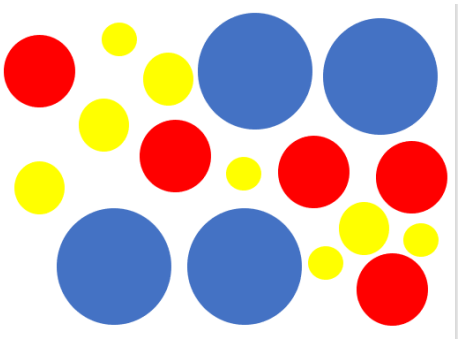


IMAGE 9: **ACTIVITY 2**

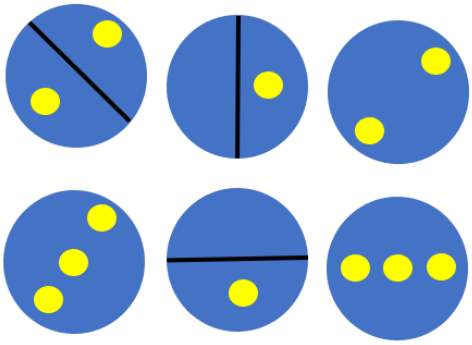
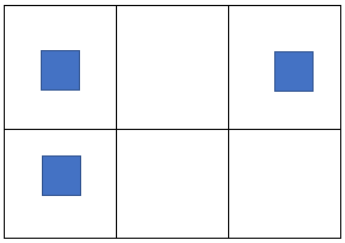


IMAGE 10: **ACTIVITY 3**

Week 5 session 9 images:



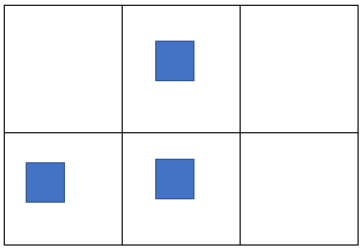


IMAGE 11: **ACTIVITY 1**

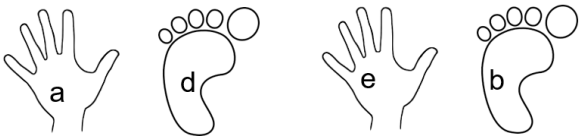


IMAGE 12: **ACTIVITY 3**

Week 10 Session 16 images:

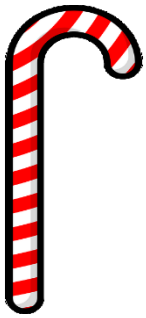
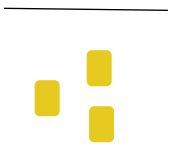
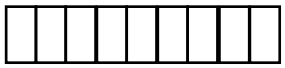


IMAGE 13: **ACTIVITY 1**

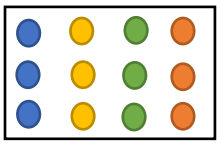
APPENDIX J

EQUIPMENT LIST

Equipment	Description	Icon
Hula Hoops 	Plastic 70cm x 70cm (Any colour)	
Stepping stones 	30cm x 20cm	
Rope 	2m long	
Alphabet/letter beanbags 	10cm x 10cm Letters a-z Blue, yellow, orange, green, red & purple	
Agility Ladder 	Blocks: 40cm x 40cm Length: 5m	
Number Dice 	Plastic/foam 15cm x 15cm	
Colour Dots 	Rubber 15cm in diameter Blue, yellow, green, orange & red	
Stilts 	15cm x 15cm	
Tactile Hands and Feet 	Rubber 10cm x 20cm	

Balance Beam 	Wood 2m x 30cm	
Hula hoop stand	Wood	
 Basket	40cm x 40cm	
Blackboard 	1m x 70cm	
Beach Balls 	Plastic 20cm x 20cm	
Tilt board 	62cm x 39.5cm x 17cm	
Beach Bats 	Wood 70cm x 30 cm	
Hurdles 	Metal 50cm x 30cm	
Cones 	Plastic 6cm x 10cm	

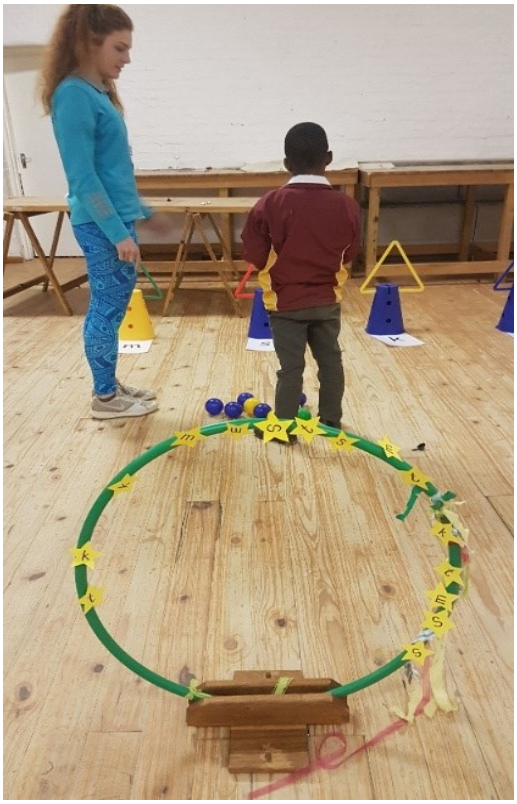
Cones with pole 	Pole: 100cm x 5cm Cones: 30cm x 10cm	
Colour shapes	Plastic Circle: 34cm x 34cm Triangle: 34cm x 34cm Square: 43cm x 43cm Red, blue, yellow & green	
 Foam roller	45cm x 15 cm	
Blocks 	Wood 10cm x 10cm x 10cm	
Scooter board 	Wood 40cm x 40cm	
Colour buckets	Plastic 30cm x 10cm Red, blue, green, yellow	
Colour balls 	10cm x 10cm Blue, red, green & yellow	
Step-n-catch		
Foam letters 	30cm x 30cm a-z	

Foam block 	70cm x 30cm	
Medicine ball 	2kg: 20cm x 20cm	
Twister mat 	1,7m x 1,4m 6 dots of each colour: Red, yellow, blue & green	
Mat 	1,5m x 70cm	
Playdough 	Any colour	
Beacon 	Plastic 20cm x 20cm	
Parachute 	3,5m in diameter	

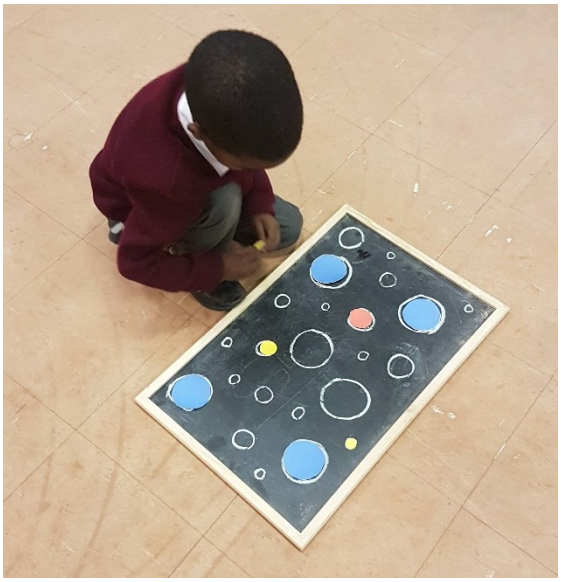
APPENDIX K

INTERVENTION PHOTOS

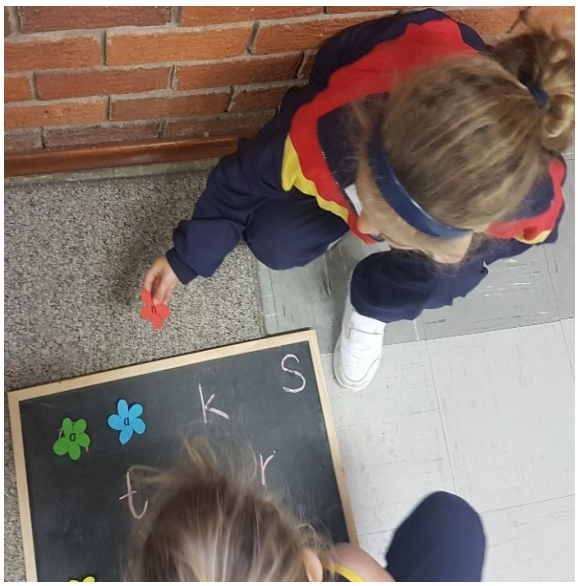
WEEK 2 SESSION 2 (ACTIVITY 2)



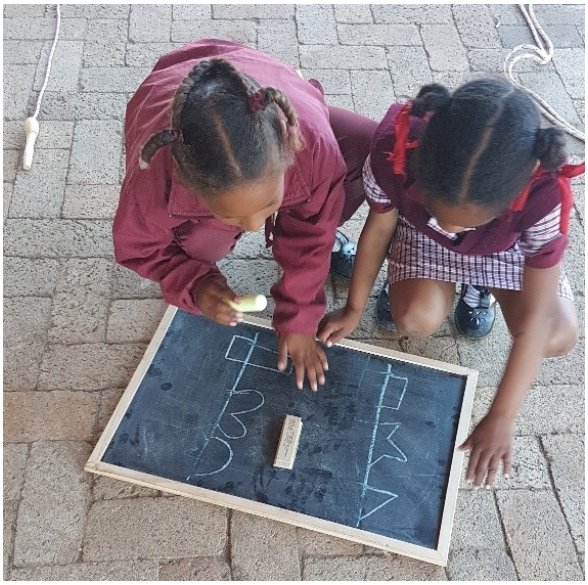
WEEK 5 SESSION 8 (ACTIVITY 2)



WEEK 5 SESSION 8 (ACTIVITY 1)



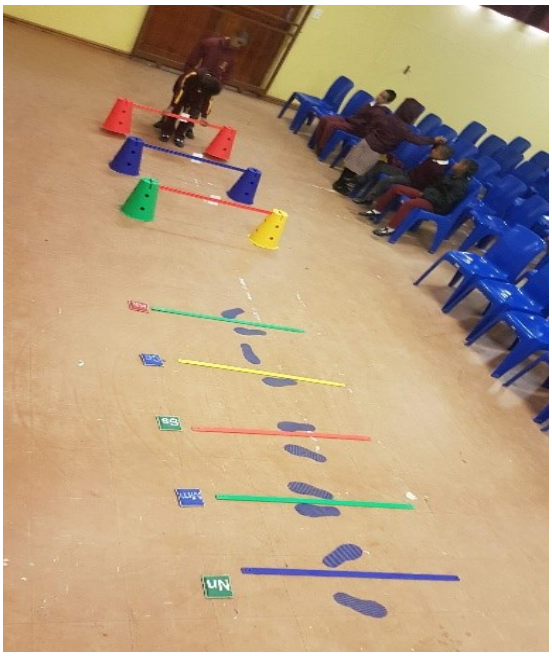
WEEK 4 SESSION 7 (ACTIVITY 3)



WEEK 6 SESSION 10 (ACTIVITY 1)

WEEK 6 SESSION 10 (ACTIVITY 1)

WEEK 6 SESSION 10 (ACTIVITY 3)



WEEK 7 SESSION 12 (ACTIVITY 2)

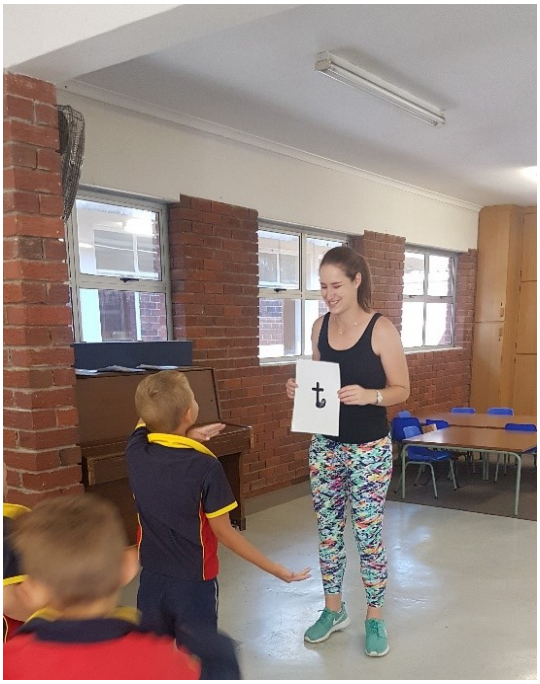
WEEK 8 SESSION 14 (ACTIVITY 2)

WEEK 9 SESSION 15 (ACTIVITY 2)

WEEK 9 SESSION 15 (ACTIVITY 3)

WEEK 10 SESSION 16 (ACTIVITY 1)

WEEK 10 SESSION 16 (ACTIVITY 2)



WEEK 12 SESSION 21 (ACTIVITY 3)

APPENDIX L

WESTERN CAPE EDUCATION DEPARTMENT PERMISSION LETTER

Audrey.wyngaard@westerncape.gov.za

Tel: +27 021 467 9272

Fax: 0865902282

Private Bag x9114, Cape Town, 8000

wced.wcape.gov.za

REFERENCE: 20180607–3040

ENQUIRIES: Dr A T Wyngaard

Miss Sharnay Botha

Village Corner 508

Nooitgedacht Estate

Kromme Rhee Road

Stellenbosch

7600

Dear Miss Sharnay Botha

RESEARCH PROPOSAL: THE EFFECT OF A PERCEPTUAL-MOTOR INTERVENTION ON MOTOR PROFICIENCY, LETTER RECOGNITION AND FORMATION IN SELECTED GRADE 1 CHILDREN

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 **19 July 2018 till 28 September 2018**

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: 08 June 2018

APPENDIX M

ETHICAL CLEARANCE LETTER

UNIVERSITEIT
STELLENBOSCH
UNIVERSITY

NOTICE OF APPROVAL

REC Humanities New Application Form

19 June 2018

Project number: 7126

Project Title: The effect of a perceptual-motor intervention on motor proficiency, letter recognition and -formation in selected Grade 1 children.

Dear Dr. Eileen Africa

Your REC Humanities New Application Form submitted on 12 June 2018 was reviewed and approved by the REC: Humanities.

Please note the following for your approved submission:

Ethics approval period:

Protocol approval date (Humanities)	Protocol expiration date (Humanities)
19 June 2018	18 June 2019

GENERAL COMMENTS:

1) In the case of a participant's withdrawal from the study, the consent/assent forms should be appropriately marked with a RED pen (corner to corner line) indicating withdrawn consent. All documents that were signed and dated should be kept for auditing purposes for at least 5 years. [ACTION REQUIRED]

2) The PI must please provide the REC: Humanities with the signed permission letters from the relevant schools once received. The permission letter from the WCED with the various stipulations should be forwarded to the schools (as stipulated in point 8 of the letter from Dr Wyngaard, Western Cape Government, Education). [ACTION REQUIRED]

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 (7126) 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:

Document Type	File Name	Date	Version
Assent form	PARTICIPANT INFORMATION LEAFLET AND ASSENT FORM	28/04/2018	1
Data collection tool	BOT description	28/04/2018	1
Data collection tool	ESSI Reading and Spelling Test description	28/04/2018	1
Data collection tool	The Beery VMI description	28/04/2018	1
Request for permission	WCED Application form	28/04/2018	1
Informed Consent Form	Consent form Bellpark	12/06/2018	1
Informed Consent Form	Consent form Weber	12/06/2018	1

Parental consent form	Consent form Bellpark	12/06/2018	1
Parental consent form	Consent form Weber	12/06/2018	1
Assent form	PARTICIPANT INFORMATION LEAFLET AND ASSENT FORM	12/06/2018	2
Request for permission	Research approval letter	12/06/2018	1
Default	Research approval letter WCED	12/06/2018	1
Default	Response to REC	12/06/2018	1
Research Protocol/Proposal	Proposal 2 ETHICS	12/06/2018	2

If you have any questions or need further help, please contact the REC office at cgraham@sun.ac.za.

Sincerely,

Clarissa Graham

REC Coordinator: Research 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.

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.

APPENDIX N

INSURANCE LETTER

Fagma Jordaan

Marsh Proprietary Limited
Alexander Forbes House
Block A,The Boulevard
Searle Street,Woodstock, 7925
P. O. Box 3060, Cape Town, 8000
South Africa
Tel +27 21 833 4700
Fax +27 21 833 4799
www.marsh-africa.com

18 June 2018

STELLENBOSCH UNIVERSITY: CONFIRMATION OF INSURANCE

The effect of a perpetual-motor intervention on motor proficiency, letter recognition and formation in selected Grade 1 children

This serves to confirm that the following cover has been arranged for Stellenbosch University and others:

1. Primary General Liability (Broad form) insurance policy number 1000/28439, underwritten by Stalker Hutchison Admiral for a limit of R5 000 000.
2. Employers Liability insurance policy number 1000/28439, underwritten by Stalker Hutchison Admiral for a limit of R5 000 000.
3. Umbrella Liability insurance policy no 1000/22890 underwritten by Stalker Hutchison Admiral for a limit of R150 000 000.
3. Total Liability limit – R155 000 000
4. Professional Indemnity insurance policy number 4000/24901 underwritten by Stalker Hutchison and Admiral for a limit of ZAR 150 000 000 and includes Medical Malpractice insurance.
5. Period of insurance: 1 January 2018 to 31 December 2018.

Subject to the terms, conditions and exclusions of the policy wordings.

We trust that you will find the above to be in order. Please do not hesitate to contact the writer should you have any queries.

Kind Regards

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APPENDIX O

LANGUAGE EDIT LETTER

UNIVERSITEIT·STELLENBOSCH·UNIVERSITY
jou kennisvennoot·your knowledge partner

21 August 2019

TO WHOM IT MAY CONCERN

I, Prof Karel J. van Deventer, hereby declare that I conducted the language and technical editing of an MSc Master thesis titled, *The effect of a perceptual-motor intervention on the motor proficiency, letter recognition and -formation of selected Grade 1 children*, authored by Ms Sharnay Botha.

Yours sincerely

KJ van Deventer

(Emeritus Associate Professor [Retired])

Sportwetenskap
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