

The relationship between object-control skills, visual-motor integration and gender of Grade 1-learners: The NW-CHILD Study

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Dissertation submitted in fulfilment of the requirements for the degree *Magister Artium* in *Kinderkinetics* at the Potchefstroom Campus of the North-West University

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Contribution of authors

This dissertation is presented in article format. The study was planned and executed by three authors. The contribution and role of each author will be explained in the table below. The co-authors hereby consent that the articles in this dissertation can be submitted for obtaining a Magister Artium in Kinderkinetics degree.

Name an surname of the author	Role of the author in this study
Mrs. Wilmarié du Plessis (WDP) (BA. Honours Kinderkinetics)	WDP, DC and AP were responsible for the completion of the study. WDP is the first author, DC is the second author and AP is the third author in both the articles.
Dr. Dané Coetzee (DC) (PhD. Human Movement Science)	DC was the supervisor in the study, and was responsible for all aspects of the study. DC was co-author on both articles.
Prof. Anita E. Pienaar (AP) (PhD. Human Movement Science)	AP was the assistant supervisor, and co-author on both the articles.

Affirmation by supervisor and assistant supervisor

I declare that the articles above have been approved and my role in the study as set out above is correct and reflects my part in the study. I further authorise that the articles, as part of the dissertation of Mrs. Wilmarié du Plessis may be published.

Dr. Dané Coetzee

Prof Anita E. Pienaar

Preface

Where to start? No masters' study is completed by means of only one person, but a group of dedicated and motivated supporters! I would like to give sincere gratitude to each and every person who supported me along the way.

First of all to our Almighty God, through Him all things are possible!

Dr. Dané Coetzee – Dané thank you for your hours of hard work, motivation and support in times when I needed it most. It may not always seem that way, but appreciate it a lot!

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Last but not in the least, I dedicate this dissertation to my Dad. Along this road of completing my dissertation I lost one of the most important people in my life. Although no longer here, only in spirit, Daddy I dedicate this to you, for everything you have always done to support me. I love you!



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SUMMARY

The relationship between object-control skills, visual-motor integration and gender of Grade 1-learners: The NW-CHILD Study

Visual-motor integration, visual perception and motor co-ordination contribute to successful academic, school and career life. Literature also indicates that delays in the skills in above mentioned abilities could lead to delays in the mastering of object control skills. Furthermore, due to the developing needs of South Africa, there is a range of socio-economic challenges, and the effects on the above mentioned skills seem to lack development. Due to the possible effect that visual skills can have on academic performance, it seems important to further investigate the effect it may have on sport skills as well.

The aim of this study was firstly, to determine the effect of gender differences and school types associated with different socio-economic conditions on the visual-motor integration, visual perception and motor co-ordination abilities of Grade 1 boys and girls in the North West Province of South Africa. Secondly, the study aimed to determine the relationship between visual-motor integration, visual perception, motor co-ordination and object control skills of Grade 1-learners in the North West Province of South Africa.

For the purpose of the first objective 816 participants (419 boys and 397 girls) were evaluated and for the second objective, 806 participants (413 boys and 393 girls) were evaluated. The test instrument used to determine the level of the participants' visual-motor skills was the Developmental Test of Visual-Motor Integration – 4th ed. (VMI-4) which consisted of the visual- motor integration test and two subtests which included visual perception and motor co- ordination. The children's object-control skills were tested with the Test of Gross Motor Development – 2 (TGMD-2) which is designed to test the gross motor functioning of children from 3 to 10 years old.

The STATISTICA software package (StatSoft, 2013) was used to analyse data. Data was analysed by means of descriptive statistics as well as a variation analyses (ANOVA). ANOVA was used to determine the interaction effect between gender and/or socio-economic status and visual-motor integration, visual perception and motor co-ordination. Independent t-testing was used to determine the effect of gender differences and socio-economic status in visual-motor

integration, visual perception and motor co-ordination. Effect sizes (d) were used to calculate practical significance of differences. Two-way frequency tables were used to compare the classifications of the different school quintiles (Quintile 1-3 = schools associated with low socio-economic status and Quintile 4-5 = schools associated with high socio-economic status) among the VMI-4-classes. The Pearson Chi-square was used to indicate the significance of the differences and the level of statistical significance was set at $p \leq 0.05$. Furthermore a Spearman rank order correlation was used to determine the correlations among visual-motor integration, visual perception, motor co-ordination, striking a stationary ball, stationary dribble, catch, kick, underhand rolling and overhand throw, and an object control total.

The results revealed that gender had no significant effect on visual-motor integration, visual perception and motor co-ordination within the respective school types associated with different socio-economic conditions. Although there were no significant differences between the boys and girls, statistically significant higher mean scores were found in school types associated with higher socio-economic status (Quintile 4 and 5) with regard to visual-motor integration, visual perception and motor co-ordination. The object control skills total had small and medium correlations with visual- motor integration, visual perception and motor co-ordination. Visual perception had the highest correlation with the object control skills total. These results contribute to our understanding of the influence that visual-motor integration, visual perception and motor co-ordination have on sport skills and more specifically ball sport skills. This knowledge enables researchers to better address problems which present in early years with regard to visual skills, as well as the negative impact which low socio-economic circumstances have on these skills in order to improve academic and sport skills later.

Keywords: Visual-motor integration, visual perception, motor co-ordination, gender, motor development, object control skills

OPSOMMING

Die verband tussen objek-kontrole-vaardighede, visuele motoriese integrasie en die geslag van Graad 1-leerders: Die NW-CHILD Studie

Visueel-motoriese integrasie, visuele persepsie en motoriese koördinasie, dra by tot akademiese sukses en 'n suksesvolle skoolloopbaan. Literatuur dui ook daarop dat 'n agterstand in die bogenoemde vermoëns kan lei tot die vertraging van die bemeestering van objek-kontrole-vaardighede. As gevolg van die ontwikkelende behoeftes van Suid-Afrika, is daar verskeie sosio-ekonomiese uitdagings, en die invloed hiervan op die bogenoemde vermoëns, blyk ontwikkeling te belemmer. Die invloed wat visueel-verbandhoudende vaardighede kan uitoefen op akademiese prestasie regverdig verdere navorsing oor die moontlike effek daarvan op sportvaardighede.

Die doel van hierdie studie was eerstens om die effek van geslagsverskille en die skool tipes wat met verskillende sosio-ekonomiese statusse geassosieer word, op die visueel-motoriese integrasie, visuele persepsie en motoriese koördineringsvermoë van Graad 1-seuns en -dogters in die Noordwes Provinsie van Suid-Afrika te bepaal. Tweedens was die studie gemik daarop om die verband tussen visueel-motoriese integrasie, visuele persepsie, motoriese koördinasie, en objek-kontrole-vaardighede van Graad 1-leerders in die Noord-Wes Provinsie van Suid-Afrika te bepaal.

Die aantal proefpersone wat vir die doeleindes van doelstelling 1 geëvalueer is, was 816 (419 seuns en 397 dogters) Graad 1-leerders, terwyl daar 806 (413 seuns en 393 dogters) Graad 1-leerders vir die doeleindes van doelstelling 2 geëvalueer is. Die meetinstrument wat gebruik is om die vlak van die proefpersone se visueel-motoriese vaardighede te bepaal, was die "Developmental Test of Visual-Motor Integration – 4th ed." (VMI-4) wat bestaan uit die visueel-motoriese integrasie toets en twee sub-toetse, wat visuele persepsie en motoriese koördinasie insluit. Die proefpersone se objek-kontrole-vaardighede is getoets, deur middel van die "Test of Gross Motor Development – 2" (TGMD-2), wat ontwerp is om die lokomotoriese- en objek-kontrole-vaardighede van kinders vanaf 3- tot 10-jarige ouderdom te toets.

Die STATISTICA sagteware pakket (StatSoft, 2013) is gebruik vir data ontleding. Die data is deur middel van beskrywende statistiek van elke toetsveranderlike ontleed asook deur middel van 'n variansie ontleding (ANOVA). ANOVA is gebruik om die interaksie effek tussen geslag en/of sosio-ekonomiese status en visueel-motoriese integrasie, visuele persepsie en motoriese koördinasie te bepaal. Onafhanklike t-toetsing is verder gebruik om die effek van geslagsverskille en sosio-ekonomiese status op visueel-motoriese integrasie, visuele persepsie en motoriese koördinasie te bepaal. Effek-groottes (d) is gebruik om die praktiese betekenisvolheid van verskille te interpreteer. Twee- rigting frekwensie tabelle is gebruik om die klassifikasie van die verskillende skool kwintiele (Kwintiel 1-3= skool tipes geassosieer met lae sosio-ekonomiese status en Kwintiel 4-5= skool tipes geassosieer met hoë sosio-ekonomiese status) tussen die VMI-4-klasse te vergelyk. Die Pearson Chi-Kwadraat is gebruik om die betekenisvolheid van die verskille aan te dui en die vlak van statistiese betekenisvolheid is vasgestel op $p \leq 0.05$. Verder is 'n Spearman rangorde korrelasie gebruik om die korrelasie tussen visueel-motoriese integrasie, visuele persepsie, motoriese koördinasie, en ses objek-kontrole-vaardighede naamlik: slaan van 'n stilstaande bal, dribbel op een plek, vang, skop, onderhandse rol en oorhandse gooi, en 'n objek-kontrole-totaal te bepaal.

Die resultate het aan die lig gebring dat geslag geen betekenisvolle effek op visueel-motoriese integrasie, visuele persepsie en motoriese koördinasie in die onderskeie skole uitgeoefen het nie. Hoewel daar geen betekenisvolle verskille tussen seuns en dogters voorgekom het nie, is statistiese betekenisvolle hoër gemiddelde standaardtellings gevind by kinders in skole (Kwintiel 4 en 5) wat met hoër sosio-ekonomiese status gepaard gaan se visueel-motoriese integrasie, visuele persepsie en motoriese koördinasie. Die objek-kontrole-vaardighede totaal het klein tot medium grootte korrelasies met visueel-motoriese integrasie, visuele persepsie en motoriese koördinasie getoon. Visuele persepsie het die hoogste korrelasie met die objek-kontrole-vaardighede totaal getoon. Hierdie resultate dra by tot meer duidelikheid met betrekking tot die invloed van visueel-motoriese integrasie, visuele persepsie en motoriese koördinasie op sport en meer spesifiek, balsport vaardighede. Hierdie kennis stel navorsers in staat om die probleme wat in die vroeë kinderjare voorkom met betrekking tot visuele vaardighede, asook die negatiewe effek van lae sosio ekonomiese omstandighede het op hierdie vaardighede, aan te spreek, wat tot beter akademiese en sportvaardighede later kan bydra.

Sleutelwoorde: Visueel-motoriese integrasie, visuele persepsie, motoriese koördinasie, geslag, motoriese ontwikkeling, objek-kontrole-vaardighede

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List of abbreviations

DCD	Developmental co-ordination disorder
FMS	Fundamental movement skills
MC	Motor coordination
NW-CHILD	North West Child-Health-Integrated- Learning and Development
NWU	North-West University
OC	Object control skills
SES	Socio-economic status
TGMD-2	Test of Gross Motor Development 2 nd ed.
VMI-4	Test of Visual-Motor Integration 4 th ed.
VMI	Visual-motor integration
VP	Visual perception
CI	Convergence insufficiency

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CHAPTER 1



Chapter 1

Introduction

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1.1 Introduction

The visual system is described as a blend of motor action systems in the human body (Gentile, 1997:3). Researchers indicate that when the visual system is insufficient in any way, motor and perceptual activities would accordingly be affected. Body awareness, co-ordination, spatial awareness and balance are some of the skills that could be affected due to poor visual skills (Anand *et al.*, 2003:2885; Bouchard & Tetreault, 2000:565; El-Kahky *et al.*, 2000:514; Lefebvre & Reid, 1998:300; Pienaar, 2010:310; Reimer *et al.*, 2000:178). Research further indicates a positive association between visual-motor co-ordination, motor skills, gross motor development, athletic co-ordination and physical activity in youth (Graft *et al.*, 2004:25; Okely *et al.*, 2001:1899; Petrolini *et al.*, 1995:928;). Cools *et al.* (2008:154) indicate that gross motor skills are important when moving, stabilizing and controlling objects, at a young age. According to various researchers, well-developed gross motor skills will contribute to more fluent movement later in life.

Various factors influence children's adjustment to school such as visual-motor co-ordination, temperament, language and general background factors such as gender and socio-economic status (Bart *et al.*, 2007:598). Among the many skills needed to

adjust in a school setting are visual-motor skills (visual-motor skills refer to the ability to match the motor outcome with the visual input) and these skills seems to be a prominent predictor of academic adaptation (Kurdek & Sinclair, 2000:449). Ercan *et al.* (2011:101) is of the opinion that delays in visual perception or motor skills could create problems in obtaining academic skills, involvement in school activities, social relations and self-esteem.

1.2 Problem statement

The ages of children at pre-school entry level vary between 3 and 6 years (Eurydice, 2002:7). This period seems to be a very sensitive period for the development of fundamental movement skills (Gallahue & Ozmun, 2006:29). Ulrich (2000:2) defines fundamental movement skills as the basic patterns of co-ordination which will lead to skilful movement later in life.

The basic fundamental skills for sport include: running, jumping, catching, kicking, throwing, swinging and hitting (Haywood & Getchell, 2005:5). In South Africa, children start their primary schooling in the year they turn seven. According to the classification of the different phases and stadia of motor development by Gallahue (1982:5), children should have mastered most of the fundamental movement skills (locomotor, stability and object control) during the fundamental phase (2 – 6 years) and should be moving into the sport specific phase (7 – 14+ years) by the time they start their formal schooling. According to Haywood and Getchell (2005:5), object control skills are referred to as ball-specific sport skills (throwing, catching, hitting and kicking), and form the foundation of motor skill adequacy and lifelong participation in physical activities. Various factors may influence the development of these fundamental skills and will be discussed accordingly.

Visual-motor integration, also referred to as hand-eye co-ordination, is the ability to integrate visual processing abilities and finger-hand movements (Aylward & Schmidt, 1986:328). Visual- motor integration is necessary for skills such as writing, catching and throwing of a ball. This ability requires intact visual perception and hand-eye co-ordination (Weil & Amundson, 1994:986), and is controlled by different areas and structures in the brain such as the parietal cortex (Schultz *et al.*, 1998:135). Wilmot *et al.* (2007:47) reported that 5-10% of the “normal” population lacked the type of co-ordination of eye and body movements. Co-ordination of the eye and body that is most frequently researched is

hand-eye co-ordination, which refers to the eyes looking at an object before the hand initiates its movement (Berthier *et al.*, 2005:342). Hand-eye co-ordination is an essential skill and is important to be successful in ball games (Markgraaff, 2010:28). Bonifacci (2004:158) reported that there were significant differences in visual-motor integration in children with good and poor gross motor abilities. Significant correlations seem to exist between visual-motor integration and visual perception (Goyen *et al.*, 1998:76).

Piaget (1948:3) indicates that visual perception cannot take place without activities that include motor elements. This researcher further indicates that visual perception is needed in order to move, but movement is also needed in order to perceive. Visual perception is the process of determining and interpreting changes in different forms of energy flow, through the environment (Williams *et al.*, 1999:61). These researchers further believe that performance, more specifically in high-speed sports, is a function of the quality of the individuals' visual system (Williams *et al.*, 1999:61).

Johnson and Wade (2007:34) reported that a variety of perceptual problems such as kinaesthetics, visuo-spatial ability and timing were associated with movement problems in less co-ordinated children. Hoare and Larkin (1991:676) found that children with co-ordination problems (also referred to as developmental co-ordination disorder - DCD) had specific difficulty with speed, force and the direction of their movements with task demands on visual perception. According to Kulp and Sortor (2003:314) there is a significant correlation between visual perception and motor co-ordination.

Motor co-ordination refers to the ability to use vision and different body actions interactively (Winnick, 2011:405). Two important components of motor co-ordination are hand-eye and foot-eye co-ordination. These two abilities are important in any sporting activity where eye-body co-ordination is needed, which is necessary for any object control skill (Winnick, 2011:406). Differences between boys and girls concerning visual-motor skills have also been found in several studies (Makhele, 2005:28; Singh *et al.*, 2010:154; Tennant, 1986:28). A study by Lotz *et al.* (2005:66) in this regard indicated that children in Grades 1 and 2 achieved one standard deviation below the mean in visual-motor skills. This is an indication that children's visual-motor skills in their study were at a low average level when entering school and that the boys scored higher than the girls in visual-motor skills. Reasons provided for these results were that boys seemed to be socialising earlier in life at home or at farms, and that the nature of the tasks given to them might have

been the reason for their advantage in developing better visual-motor skills than girls (Lotz *et al.*, 2005:66). In an intervention study by Singh *et al.* (2010:154) the boys' values in visual-motor skills exceeded those of the girls once again. Makhele's (2005:28) study also proved that in the 9-year-old group, the boys proved to have performed better in visual-motor skills. However, several studies indicated that girls performed better than boys in visual-motor skills (Aylward & Schmidt, 1986:329; Brown, 1990:280; Harris, 1963:369), which indicates controversy in research findings regarding gender differences. According to literature gender differences also seem to affect different motor skills.

Boys seem to choose to participate more in manipulative types of activity (object control skills) such as soccer, basketball and handball, while girls prefer to participate in locomotor type activities such as gymnastics and dance at a young age (Božanić *et al.*, 2011:92). In general, girls tend to have higher mastery of locomotor skills and boys higher mastery of object control skills (Hardy *et al.*, 2010:505). The literature indicates that not only gender but also socio-economic status play a role in the development of visual-motor integration, visual perception and motor co-ordination skills (Cliff *et al.*, 2009:151; Krombholz, 1997:1168; Nelson *et al.*, 1986:283).

Lotz *et al.* (2005:64) found that motor development could be delayed if children lived in poor socio-economic environments. A reason provided was that poor socio-economic environments could limit the opportunities to learn in a creative manner through play. These researchers (Lotz *et al.*, 2005:64) also indicated that socio-economic status could be an important predictor for the development of visual-motor skills, and girls might be even more at risk for larger developmental delays than boys. Noble *et al.* (2005:83) indicate that socio-economic status and cognitive function have an effect on language, visual perception, visual-spatial relations and memory. Lotz *et al.* (2005:64) further reported that children with a high socio-economic status had more advanced visual-motor development, compared to children with a low socio-economic status. From the above-mentioned literature it seems that socio-economic status plays an important role in the development of visual-motor skills. Due to South Africa's diverse population and socio-economic circumstances, many challenges with regard to early childhood development occur in this country (Pienaar, 2004:75). The inequality between children from high and low socio-economic circumstances with regard to their motor skills development seems more important to be studied today than ever.

Limited research has, however, been done on the relationship between visual-motor integration, visual perception, motor co-ordination and object control skills, as well as on the possible differences between boys and girls with regard to the relationship of these skills and the effect that socio-economic status may have on the above mentioned skills. This research is therefore based on the following research questions: Firstly what is the effect of gender and socio-economic status on visual-motor integration, visual perception and motor co-ordination of Grade 1 boys and girls in the North West Province of South Africa, and secondly, what is the relationship between visual-motor integration, visual perception, motor co-ordination and object control skills of Grade 1 learners in the North West Province of South Africa. Answers to these questions will generate scientific knowledge, which will enable professionals such as Kinderkineticists, occupational therapists and teachers to support children by implementing perceptually appropriate motor programs. It will also enable them to address the influence that visual perceptual abilities may have on the performance of object control skills, and of the importance of stimulation of these skills, in which case sport and school programs can be adapted to ensure optimal stimulation. Furthermore it will enable Kinderkineticist to provide relevant motor programs to children from the various socio-economic circumstances based on their current status of visual-motor skills.

1.3 Objectives

The objectives of this study are to determine:

- 1.3.1 the effect of gender and school types associated with different socio-economic conditions on the visual-motor integration, visual perception and motor co-ordination abilities of Grade 1 boys and girls in the North West Province of South Africa; and
- 1.3.2 the relationship between visual-motor integration, visual perception, motor co-ordination and object control skills of Grade 1-learners in the North West Province of South Africa.

1.4 Hypotheses

The study is based on the following hypotheses:

- 1.4.1 Boys and girls in school types associated with low socio-economic circumstances

will show significantly poorer visual-motor integration, visual perception and motor co-ordination than boys and girls in Grade 1 in school types associated with higher socio-economic status (SES) in the North West Province of South Africa.

1.5 There will be a positive correlation between the Grade 1-learners' visual-motor integration, visual perception, motor co-ordination and object control skills in the North West Province of South Africa. Structure of dissertation

This dissertation is presented in article format. The structure of the dissertation will be as follows:

1.5.1 Chapter 1 includes the introduction, problem statement and objectives of the study.

All citations are according to the adapted Harvard-guidelines as prescribed by the North-West University. The references of Chapter 1 follow directly after the chapter and will be presented according to Harvard-prescriptions according to the North-West University

1.5.2 Chapter 2 provides a literature overview on the relationship between visual-motor integration and object control skills and the effect of socio-economic status and gender differences on these skills. All the references of Chapter 2 follow directly after the chapter and presented according to Harvard-prescriptions according to the North-West University.

1.5.3 Chapter 3 is presented in the form of an article, with the title: ***Influences of gender and socio-economic status on visual-motor integration, visual perception and motor co- ordination in Grade 1-learners: the NW-CHILD study.*** This article will be presented to the *Human movement science journal*. Guidelines for authors who present their articles to this journal are placed in Addendum B. Due to technical purposes and to present the dissertation uniformly, amendments were made to the guidelines given by the journal: the article margins are according to the rest of the dissertation, headings are numbered and tables and figures are placed in the text, rather than at the end of the article. These modifications make the dissertation easier to read and fit in with the rest of the dissertation.

1.5.4 Chapter 4 is also presented in the form of an article, with the title:

Interrelationships between visual-motor integration, visual perception, motor coordination and object control skills of Grade 1-learners: the NW-CHILD study. This article has been presented to the *South African journal for research in sport, physical education and recreation*. Guidelines for authors who present their articles to this journal are placed in Addendum C. Due to technical purposes and to present the dissertation uniformly, amendments were made to the guidelines given by the journal: the article margins are according to the rest of the dissertation, headings are numbered and tables and figures are placed in the text, rather than at the end of the article. These modifications make the dissertation easier to read and fit in with the rest.

1.5.5 Chapter 5 includes the summary, conclusion and recommendations of the study.

Subsequently, Chapter 2 will provide an overview discussion on the relationship between visual- motor integration, visual perception, motor coordination and object control skills and the effect of socio-economic status and gender on above mentioned skills.

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CHAPTER 2



Chapter 2

Literature overview: Relationships between visual-motor integration and object control skills and the effect of socio-economic status and gender

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2.1 Introduction

The visual system and eye control, also known as ocular motor control, is crucial in the development of gross-, sport-, fine motor and academic abilities (Desrocher, 1999:36; Erhardt *et al.*, 1988:84; Orfield, 2001:114).

One of the many roles of the visual system includes promoting better motor learning (Cheatum & Hammond, 2000:263; Willoughby & Polatajko, 1995:789). Effective visual tracking and visual perception skills are necessary for effective motor movements (Cheatum & Hammond, 2000:266). Depth perception and figure-ground recognition plays an important role in motor planning when it comes to motor movement (Willoughby & Polatajko, 1995:789). Depth perception refers to the ability to determine distance between objects and figures. While figure-ground recognition is the ability to differentiate between the fore- and background (Schneck, 2010:376). During movement, depth perception is needed to be able to produce the correct response with adequate co-ordination. Figure-ground recognition further plays an important role with regards to tracking a ball when it is hit or while catching a ball (Willoughby & Polatajko, 1995:789). Vision provides important information about spatial orientation and according to researchers it is necessary to maintain balance in challenging situations (Anand *et al.*, 2003:2885; El-Kahky *et al.*, 2000:514). Balance, body awareness, spatial orientation as well as co-ordination is influenced by effective visual functioning (Bouchard & Tetreault, 2000:565; Cheatum & Hammond, 2000:263; Pienaar, 2010:310; Reimer *et al.*, 2000:178; Tolla, 2000:72; Winnick, 2000:163).

A study by Van Heerden *et al.* (2011:40) on 52 children, ranging from 6-9 years in the Gauteng province of South Africa, found that children in low socio-economic circumstances received lower mean scores in comparison to children in middle- and high socio-economic circumstances, with regard to visual-motor integration, visual perception and motor co-ordination. Reasons given for the lower mean scores in children of poor socio-economic circumstances were factors related to socio-economic circumstances which included resources for children such as toys, extramural and sport facilities (Van Heerden *et al.*, 2011:42).

The objectives of this study were firstly to determine the effect of gender and socio-economic status on the visual-motor integration, visual perception and motor co-ordination

abilities of Grade 1-learners in the North West Province of South Africa and secondly to determine the relationship between visual-motor integration, visual perception, motor co-ordination and object control skills of Grade 1-learners in the North West Province of South Africa. Relevant research will accordingly be discussed, to provide background for the above-mentioned objectives. Firstly a literature review will be given on the visual system, the visual system's anatomy, the sensory systems involved in vision, terminology regarding the visual system, especially visual- motor integration, visual perception and motor co-ordination. Secondly the occurrence, symptoms and consequences of visual problems and the possible effect that gender and socio- economic status could have on the three main visual abilities, namely visual-motor integration, visual perception and motor co-ordination, will be discussed. Thirdly the object control skills will be investigated with regard to relevant terminology and consequences. Both academic and sport-related problems, due to movement problems will be investigated and lastly the effect of gender and socio-economic status on object control skills and the influence of visual-motor integration, visual perception and motor co-ordination skills on object control skills will be discussed.

2.2. The visual system

Out of all the information the brain receives, 80 to 90% is perceived through the eyes (Cheatum & Hammond, 2000:263). Children with visual problems are sending misleading information to the brain, and when these misleading images are combined with vestibular, tactile, proprioceptive and auditory systems, the information that is received can be in disarray (Cheatum & Hammond, 2000:263). Pienaar (2010:310) describes vision as being the primary source of information to which the brain and body reacts to develop and maintain balance, co- ordination, spatial awareness and body awareness. Visual information that may be inaccurate will cause the learner to react faulty, which in turn will cause deviations. This can contribute to conditions which are known as motor delays or motor deviations (Pienaar, 2010:310).

Vision is the ability to see far and wide, and also refers to the sharpness and clarity of the stimuli (Cheatum & Hammond, 2000:263; Pelz & Canosa, 2001:3587). Vision is not merely the ability to see specific letter types or sizes at 20 feet or 6 metres, but it refers more specifically to a complex and adaptable way of gathering information as well as a system which gathers, groups, analyses, accumulates and stores information (Cohen *et al.*, 2004:9).

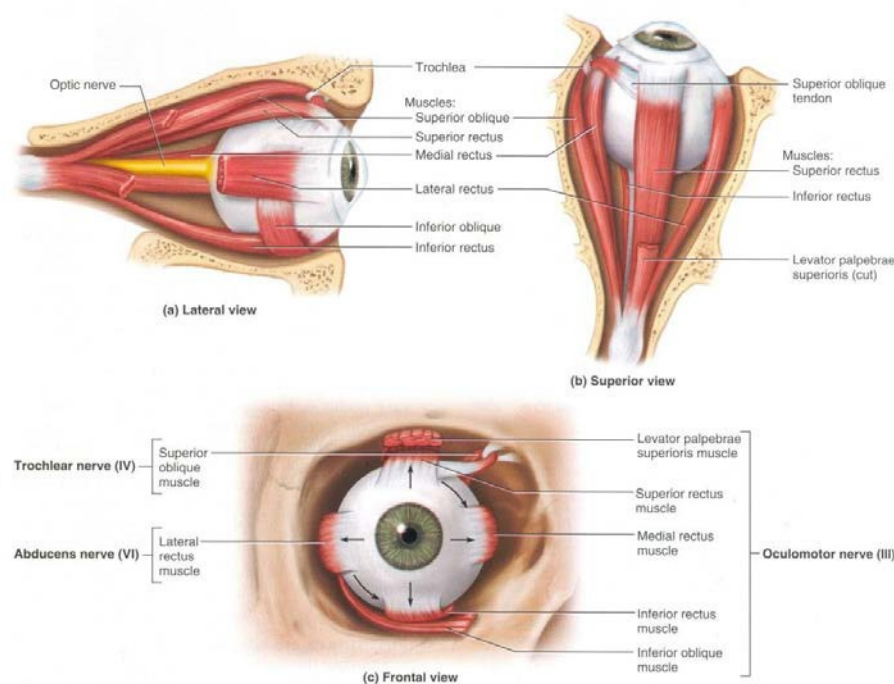


Figure 2.1 – The skeletal eye muscles (Saladin, 2007:614)

According to the Optometrists Network (2004) adequate visual functioning is dependent on the following:

- Intact visual lanes, which include eye health, visual sharpness and defragmentation;
- Visual efficacy including accommodation (focus), binocular vision and eye movement and
- Visual information processing which includes identification, discrimination, form perception and integration with other senses (Optometrists Network, 2004).

Good vision requires extraordinary visual and/or perceptual skills, which involve the eyes sending information to the brain (Campher, 2008:85). The eyes are known as the receptors of the visual system, which have a ball-shaped appearance and is approximately one inch long. Each eye is located in a socket, otherwise known as the orbit. This socket protects the eyes from injury. The eye consists of three layers: the outer layer (cornea), the choroid and the white flesh called the sclera. The eye is then connected by six muscles which are located on the outside edge at the top, bottom and sides of the sclera (see fig. 2.1). According to Wilson and Falkel (2004:4) these six muscles surrounding the eye, control the eye movements. The four-rectus muscles (superior, inferior, medial and lateral) are responsible for moving the eye from left to right and up and down, while the two oblique muscles are responsible for rotating the eye inward and outward. The iris is the coloured part of the eye which has an opening in the middle, called the pupil. The iris is responsible for controlling

the amount of light which enters the eye. When a large amount of light enters the eye, the iris constricts, when the light is dim it expands. The lens which divides in the eye in an anterior and posterior side is located behind the pupil. The retina is located inside the eye and constitutes for almost 60% of the space used, and this forms the posterior half of the eye. At the back of the retina lies the optic nerve (Wilson & Falkel, 2004:4).

According to Cheatum and Hammond (2000:265) the eyelids can be compared to the lens of a camera. When the lids are open, light enters the eye. Sight is the process of light rays converted into visual images. The light passes through the cornea and pupil to the lens. The lens then focuses the image onto the retina, and as the images goes through the retina they are converted into impulses and passed via the optic nerve to the brain (Cheatum & Hammond, 2000:265).

According to Pienaar (2010:310) children 2-4 years of age rely on their vision to maintain correct posture and balance, while children 4-6 years of age start to rely more on proprioceptive information for balance, although vision continues to play an important role. This researcher (Pienaar, 2010:310) further indicates that good eye-function is necessary for eye-hand and eye-foot tasks as well as spatial awareness about the environment. The visual system forms only a part of the larger sensory system and will be discussed accordingly (Pienaar, 2010:310).

2.2.1 Sensory systems involved in vision and visual perception

The sensory system forms part of the biological system of a human being, and receives all the information from the senses due to interaction with the environment (Pollock, 2000). The vestibular system, proprioception and the visual system have an effect on the learner's academic learning and participation in class activities (Cheatum & Hammond, 2000:266). The sensory organs of the vestibular system are located in the inner ear and consist of three semi-circular canals as well as the utricle and saccula (Cheatum & Hammond, 2000:144). The vestibular system is the system in the brain which receives information from other senses and systems, then co-ordinates and adapts it this intern has an effect on the auditory, visual function, muscle tone, balance and proprioception (Cheatum & Hammond, 2000:150). This system plays an important role in managing the movement of the eye muscles and fixation of the eyes, which influence the eye's ability to focus and fixate (Cheatum & Hammond, 2000:152). The vestibular system also plays an important role in

muscle tone that creates a stable base from which the head and neck movements take place to make vision possible (Cheatum & Hammond, 2000:150). Proprioception refers to the brain's unconscious perception of the body in the environment as well as the relationship of the limbs to each other (Cheatum & Hammond, 2000:187). The brain receives information from the inner ear, with regards to the position of the head, the effect of gravity and the speed of the body, and information from the eyes, with regards to the environment and the position of the body in the environment.

2.2.2 Terminology

The visual system consists of a variety of functions namely vergence, focusing, tracking, binocular fusion, visual memory and depth perception and influences functions such as visual-motor integration, visual perception and motor co-ordination. Subsequently all visual functions related to this study will be discussed.

Visual-motor integration refers to the ability to integrate visual skills with fine motor skills. Weil and Cunningham-Amundson (1994:987) stress that visual-motor integration needs adequate visual perception, psychomotor speed and hand-eye co-ordination.

Visual perception can be defined as the process responsible for receiving stimuli and the cognition of visual stimuli (Schneck, 2010:383; Sortor & Kulp, 2003:758). The sensory function, or otherwise-called visual-receiving component, is the process of receiving, organizing of information from the environment as well as the specific cognitive functions which produce the visual cognitive component to be able to organize, give structure and interpret visual stimuli, in other words give meaning to what is seen (Schneck, 2010:373). Together these components enable a person to understand what he/she sees and both these components are needed for functional vision. Visual perceptual abilities include: recognition and identification of forms, objects, colours and other qualities. Visual perception also enables a person to configure size and spatial relationships. This ability develops according to a hierarchy (Warren, 1993:42). The development of visual perception can be divided into a hierarchy which starts with visual sharpness and ends with the adaptations made through vision.

Visual perception further comprises of a vast number of terms (Schneck, 2010:383). It is however important to differentiate between the following two terms: **object/form perception**

and **spatial perception**. Object/Form perception comprises the following three components: **form consistency, visual closure and figure-ground perception**. Form consistency is the ability to identify forms and objects in different environments (Scheck, 2010: 376). Visual closure is the ability to identify a form or object when incomplete (Scheck, 2010:376) and figure-ground perception is the ability to discriminate a target from its background (Schoemaker et al., 2001:112). According to researchers babies only recognize primary colours during 3-4 months and following an object develop until 8-9 months (Gabbard, 2008:13).

Visuo-cognition refers to the ability to use visual input to complete cognitive processing. Vision cannot be altered without altering cognition (Schneck, 2010:378). **Visual memory** is there to support visual cognition and is the ability to store information for later or to recall it immediately (Schneck, 2010:378). To be able to understand and mentally manipulate visual input, one must have visual memories of objects to compare and contrast. Pattern recognition refers to the following: memory lay down and memory accurate used by the central nervous system (CNS) (Schneck, 2010:383). This involves the identification of salient features of objects. Visual search and scanning are required for pattern recognition. It occurs on two levels and leads to an organized efficient and predictable pattern (Schneck, 2010:383).

Visual attention describes the process of filtering irrelevant information and only maintaining relevant information (Steinman *et al.*, 1996:6). It varies from global to focal, depending on the type of visual analysis needed. All these levels must work together to produce accurate visual perception. Furthermore, visual perception is important for movement due to the fact that it plays a crucial role in catching, throwing and kicking abilities as well as running and other fundamental abilities (Winnick, 2000:287). According to Winnick (2000:287) figure-ground perception and spatial orientation are as crucial for effective movement as visual perception.

Spatial orientation develops after directional awareness has developed, and it refers to the position in space as well as the position in space in relation to other objects (Sherill, 2004:339). Spatial awareness helps to develop components such as coordination, self-confidence and thinking skills (Poole *et al.*, 2006:25). This skill is also a linguistic skill due to the fact that children learn positional words such as *on top* and *at the back*. Learning this type of positional vocabulary is essential to spatial orientation, and is a child's first introduction to direction, distance and location (Poole *et al.*, 2006:25). Problems with spatial orientation could lead to confusion when working with quantitative

thoughts. Children who, for example do not grasp the concepts of first and last, are not ready for formal counting. Mathematics could provide children with spatial problems with additional problems. If they do not understand spatial concepts such as *up-down*, *in front of at the back* or *left-right*, mathematical problems such as using positive and negative numbers and formulas will arise (Pienaar, 2010:163).

Visual motor co-ordination, also referred to as motor co-ordination, is the ability to co-ordinate vision and body movements (motor movement) (Winnick, 2005:368). According to Winnick (2005:369) motor co-ordination plays a crucial role in hand-eye co-ordination and is especially important in fine motor activities such as drawing, painting, writing and manipulating toys. The continuous conscious movement or motor co-ordination is crucial for motor development (Haywood & Getchell, 2005:74).

2.2.3 Incidence of visual problems

According to Cheatum and Hammond (2000:263), approximately 25% of school-aged children experience visual problems. These researchers reported that 9% of children who experienced visual problems also experienced written work on the board as hazy, 37,2% lost their place while reading, 28% blinked their eyes while catching a ball and 38,7% had watery eyes when reading or writing. A study by Coetzee and Pienaar (2013:4079) in the North-West province, indicated that 7-8 year old children with developmental co-ordination disorder (DCD) had a range of visual problems including the following: fixation (both eye = 81,25%; right eye = 87,5% and left eye = 93,75%), ocular alignment (both eyes = 84,37%; right eye = 84,37% and left eye = 84,37%), convergence- divergence (71,88%) and tracking (both eyes = 90,6%; right eye = 90,6% and left eye = 100%). Pienaar (1993:118) conducted a study on 289, 6-9 year olds with neurological-based motor delays and found the children to have problems with fixation (both eyes = 0,3%; right eye = 5,9% and left eye = 6,9%). On average 4,4% of the children that participated in this study had fixation problems. According to Borsting *et al.* (2012:2) 5% of school-aged children are affected by a condition called convergence insufficiency (CI). CI is when the eyes are unable to turn inward together in order to focus for example when reading. CI causes visual fatigue, headaches as well as double vision when reading.

2.2.4 Symptoms of visual problems

Children often experience delays in academic and sport skills which could be due to visual problems. Researchers indicate the following symptoms as signs that there might be problems with the visual system (Adler, 2002:565; Auxter *et al.*, 1997:439; Cheatum & Hammond, 2000:274; Halle, 2002:16; Van Noorden, 1976:334):

The child experiences the following symptoms when he/she is reading, writing or drawing:

- he/she loses their place,
- he/she struggle to write from the blackboard,
- he/she tend to move closer to his/her book with his/her eyes,
- he/she skip words or lines,
- he/she easily tire whilst doing these activities,
- he/she frown a lot,
- words become hazy,
- he/she tend to close one eye with his/her hand, to see better or he/she just avoid these activities,
- he/she squint or bat his/her eyes a lot, to either see better or to get a clearer image,
- his/her eyes become red and watery often accompanied by headaches,
- he/she rubs his/her eyes after a short while during visual activities.

Other symptoms related to visual stress:

- he/she often becomes irritated and restless,
- gross motor activities are clumsy, including coordination, spatial orientation, balance and midline problems,
- exhibits a short attention span and poor concentration,
- usually sits with bad posture,
- associated movements,
- struggles to assess distances,
- avoids climbing activities,
- double vision,
- dizziness,
- distorted images,
- struggles with activities where the midline has to be crossed,

- slow reaction speed,
- problems in sport and motor activities.

From the above-mentioned symptoms it is clear that visual problems could have an influence on a child's welfare. The consequences of these visual problems on a child's academic and sport skills will be discussed briefly.

2.2.5 Consequences of visual problems

Visual information plays an important role in the regulating of proprioceptive and limb positioning, in other words the position that the arms and legs have to take in order to complete its function (Mon-Williams *et al.*, 1999:247; Horowitz & Röst, 2007:68). Visual abilities are important in almost every activity that a person does and include crawling, walking, eating, reading, writing, playing, exercising and motor abilities (Cheatum & Hammond, 2000:266; Wilson & Falkel, 2004:2; Willoughby & Polatajko, 1995:789). If any visual problems occur, it may lead to certain academic and sport delays, which will be discussed accordingly.

2.2.5.1 Academic problems

The visual system plays an important role in learning to read, identifying shapes and writing. A study by Weber (1980:305) found that there was a correlation between visual problems and academic performance.

Visual-motor integration is necessary for skills such as writing, keyboarding and throwing or catching of a ball (Avi-Itzhak & Obler, 2008:1007). According to Satz and Friel (1974:347) delays or deficits in visual-motor integration could lead to learning disabilities later in life. Weil and Cunningham-Amundson (1994:986) indicated that visual-motor integration was one of the crucial skills in teaching children to write. Research on Grade 1 and 2 South African children found that these children achieved one standard deviation below the mean in visual-motor integration skills, indicating that their visual-motor integration skills were below average when they entered the school (Lotz *et al.*, 2005:66). Volman *et al.* (2006:456) furthermore indicated that children, who had poor writing skills, also had possible delays in visual-motor integration, visual perception and motor co-

ordination.

Visual perception is a skill which is often assessed due to its relation to learning readiness, and academic performance in reading, maths and writing (Sortor & Kulp, 2003:762). Visual perception capacity and the visual system's ability to manage motor behaviour also known as visual-motor integration can affect abilities such as motor skills, handwriting and academic achievement. Problems with visual perception can lead to delays in motor abilities (Levebre & Reid, 1998:311). Tekok-Kiliç and colleagues (2010:1) found that defects in children's visual perception skills also caused problems in their daily life. Researchers (Kulp, 1999:161; Solan, 1987:979; Willows, 1998:205) further indicated that there was a link between visual perception skills and academic skills such as reading, writing and mathematics.

Motor co-ordination plays an important role in hand-eye co-ordination. This ability is important for tasks such as cutting, drawing, colouring and manipulation of clay and especially for writing (Winnick, 2005:369). Researchers (Arter *et. al*, 1996:25; Erhardt *et al.*, 1988:84) found that if motor co-ordination was negatively affected, hand-eye and fine-motor skills would be negatively affected, and this would then lead to academic problems. Pienaar *et al.* (2013:373) found in their study of 812 children (418 boys and 394 girls) in the North West Province of South Africa, that visual-motor integration and visual perception was highly significant for mastery in math, reading and writing.

2.2.5.2 Sport related movement problems

From all the information the brain receives, 80% are received from the eyes (Cheatum & Hammond, 2000:263), therefore it can be said that vision is an extremely important factor in sport performance.

According to researchers, visual abilities play an important role in the development of hand-eye and foot-eye co-ordination, which influence most sports and abilities directly (Wilson & Falkel, 2004:11, Winnick, 2005:369). According to Wilson and Falkel (2004:4) vision can be used to better performance in any sport, static or dynamic, whether it is batting better in cricket or receiving better scores in golf. Usually learners with visual problems struggle to change direction with their eyes, losing the object with their eyes or moving the head instead of the eyes (Erickson, 2007:13).

According to Dewey *et al.* (2002:906) children who experience problems with motor abilities, will most likely also have problems with attention and visual perceptual problems in relation to their peer group (Dewey *et al.*, 2002:914; Geuze & Börger, 1993:11; Kaplan *et al.*, 1998:486; Sugden & Wann, 1987:225; Wessels, 2007:57).

2.3 The effect of gender on visual-motor integration, visual perception and motor co-ordination skills

There is some controversy in the literature regarding gender differences and visual-motor integration. In her study of 55 boys and 48 girls, aged 5-6 years, from an upper-middle class suburban area, Aylward (1986:330) found that the girls performed better than the boys, however not all researchers support this notion (Frey, 1996:179; Scott, 1981:483). Makhele (2005:28) found in her study of 671 children, aged 7-9 years, in the Free State Province of South Africa, that the boys' visual-motor integration skills were better developed than the girls'. Lotz *et al.* (2005:66) studied 339 children (171 males, 168 females) in the Stellenbosch region and also found that the boys scored higher than the girls in respect of visual-motor skills. According to Lotz *et al.* (2005:66) reasons for these gender differences could be that tasks given to boys at home or on farms might be more advantageous in developing visual-motor integration. In contrast to the above-mentioned studies, the study of Aylward and Schmidt (2001:330), consisting of 55 boys and 48 girls, between the ages of 4 and 6½, found no significant difference between the boys and girls regarding their visual-motor integration skills. Tekok-Kilic and Elmastas-Dikec (2010:1) also reported in their study of 1887 children, aged 6,0-15,11 years, from Bursa, that there were no gender differences in visual-motor integration among the different age groups that they evaluated.

The literature further indicated some controversial findings regarding gender differences and visual perception. Research done by Ahmetoglu *et al.* (2008:833) found a significant difference between boys and girls in their visual perception skills. This researchers' study was conducted on 60 children (30 = normally developed and 30 = children with ADHD), aged 7, from Edirne. These researchers indicated that the girls performed better during motor co-ordination, figure- ground perception and position in space subtests of the "Frostig Developmental Test of Visual Perception" than the boys. Fliers *et al.*'s (2007:4) research on 486 children with ADHD (375 boys, 111 girls) and 269 children with no ADHD (108

boys, 161 girls), aged 5 to 19 years, living in the Netherlands, reported that the boys with ADHD seemed to have more motor co-ordination problems, than the girls with ADHD. The same tendency was found in the control group where the boys had more co-ordination problems than the girls (Fliers *et al.*, 2007:5). Pienaar *et al.* (2013:373) studied the visual-motor integration, visual perception and motor co-ordination skills of 812 children (418 boys and 394 girls), with a mean age of 6,78 years in the North West Province of South Africa. This study's results indicated that girls tended to performed better than the boys in the above-mentioned skills (Pienaar *et al.*, 2013:375). Literature indicates that socio-economic status can play a potential role in visual-motor integration, visual perception and motor co-ordination. This will be discussed in detail.

2.4 The effect of socio-economic status on visual-motor integration, visual perception and motor co-ordination skills

According to researchers (Beery, 1997:122; Dunn *et al.*, 2006:951; Van Heerden *et al.*, 2011:42), children that were living in lower socio-economic classes did show delays in visual-motor integration, visual perception and motor co-ordination. According to Bowman and Wallace (1990:610) children from higher socio-economic status received higher marks in visual-motor integration tasks compared to their latter. Goodway and Branta (2003:37) further indicated that children from low socio-economic status showed developmental delays with regards to their fundamental skills. Richmond and Norton (1973:282) found that children living in lower socio- economic communities achieved lower marks in visual perceptual tasks than advantaged children. Research by Kattouf and Steele (2000:73) supported Richmond and Norton's (1973:282) findings, because these researchers also found that children from a low socio- economic background showed more visual perceptual delays than their peers. Noble *et al.* (2005:83) indicated that socio-economic status and cognitive function had an effect on language, visual perception, visual-spatial relations and memory. Ferguson *et al.* (2001:327) further indicated that socio-economic status, which included criteria such as the educational level of mothers and family members, as well as social and emotional factors could all lead to children falling behind, compared to their peers and the above-named factors could also affect the academic and behavioural skills of children.

Lotz *et al.* (2005:64) also indicated that socio-economic status can be an important predictor of visual-motor skills, and girls may even be more at risk for larger developmental

delays than boys. Lotz *et al.* (2005:64) conducted a study on 339 South African learners in the Stellenbosch region, ranging from Grade 1 to 4 and reported that children with a high socio-economic status had more advanced visual-motor development, compared to children with a low socio-economic status. Ercan *et al.* (2011:102) found in their study of 148 children (78 = low socio-economic status and 70 = high socio-economic status) from Edirne that the effect of socio-economic status on visual-motor integration, visual perception and motor co-ordination varied. These researchers (Ercan *et al.*, 2011:102) found a higher mean score for children from a high socio-economic background compared to the children in a low socio-economic status. Ercan *et al.* (2011:102) also reported a significant difference in visual-motor integration ($p < 0.01$) and motor co-ordination ($p < 0.05$) with regards to the different socio-economic statuses.

Martin *et al.* (1977:466) found in their study of the effect of race and influences of social class on the development of visual-motor integration, that white children from a high socio-economic class had better visual-motor integration skills compared to black children from a low socio-economic class. A study conducted by Pienaar *et al.* (2013:3) on 812 children (418 boys and 394 girls) in the North West Province of South Africa, found that socio-economic status was related to academic success, where lower socio-economic status predicted poorer academic results ($p < 0.01$).

Research by Vandendriessche *et al.* (2012:113) studied the relationship between motor co-ordination and socio-economic status in Flemish children, consisting of 1955 participants, 6-11 years (52% boys and 48% girls). These researchers found that motor co-ordination differed significantly over the socio-economic span among girls, where the girls from a higher socio-economic status scored higher means compared to girls from a low and middle socio-economic status. In contrast, boys showed no significant differences in motor co-ordination scores based on socio-economic status (Vandendriessche *et al.*, 2012:124). From the above literature the assumption can be made that socio-economic status therefore plays an important role in visual-motor development. Visual-motor integration, visual perception and motor co-ordination play a role in motor skills, which include object control skills. These skills will be discussed accordingly.

2.3 Object control skills

Before attempting to understand object control skills and the different influences such as

gender, socio-economic status and the relationship with visual-motor integration, visual perception and motor co-ordination, the relevant terminology will first be discussed.

2.5.1 Terminology

Motor development can be divided into two categories, namely fine- and gross motor development (Malina *et al.*, 2004:196). **Fine motor skills** refer to smaller movements that need closer hand-eye co-ordination. Typical fine motor skills would include drawing, building blocks, using scissors and writing (Gallahue & Ozmun, 2006:18). **Gross motor development** includes all the fundamental motor skills (FMS) needed to move in space (locomotor ability), to maintain balance against gravitation (stability) and to receive and exert power from and on an object (manipulation) (Burton & Miller, 1998:58; Gallahue & Ozmun, 2006:187). **Fundamental motor skills** (FMS) are general motor activities with a specific pattern. Most skills used during sport are the FMS advanced components (Burton & Miller, 1998:407). According to Gallahue and Cleland-Donnelly (2003:52) fundamental movement skills is an organized pattern of motor skills which include a combination of movement patterns of one or more body part. According to Haywood and Getchell (2005:5) object control skills (ball specific sport skills) form the bases of motor skill adequacy and lifelong participation in physical activities. **Locomotor skills** are those skills that enable someone to move from one point to another and can include: running, galloping, skipping, leaping, gliding and jumping. **Manipulation skills (object control skills)** are those skills that have to do with movement from the feet or hands, such as catching, throwing, kicking, rolling, dribbling and hitting (Goodway & Robinson, 2006:2). **Stability skills** are those skills that have to do with maintaining an upright position or control over the body when walking, sitting and standing (Gabbard, 2008:14).

The ages of children in pre-school range from 3-6 years (Eurydice, 2002:7). This period seems to be a very sensitive period for the development of FMS (Gallahue & Donnelly, 2003:448). Most children are naturally inquisitive and like to play and explore. For this reason most of these FMS develop naturally and even more so when stimulation, opportunities to play, physical activity and sport is made available to them (Cools *et al.*, 2008:154). Mastering certain FMS is a pre-requisite for normal daily functioning and participation in physical- and sport-specific activities later in life (Cools *et al.*, 2008:154). In South Africa children start their primary schooling in the year they turn 7. According to the classification by Gallahue and Ozmun (2006:49) of the different phases and stadia of motor development (see

fig. 2.2), children at this stage should have mastered the FMS and should be moving into the sport skill phase.

Development is the general term used to describe the broadening of an individual's movement capability to progressively lead to better functioning (Gabbard, 2008:6). Motor development refers to progressive changes in motor behaviour throughout the lifespan, and which is caused by an interaction between the requirements set by the task, the biological composition of the individual and the challenges of the environment (Gallahue & Donnelly, 2003:36). According to Gabbard (2008:13) and Gallahue and Ozmun (2006:53) children go through four distinct phases from birth till adulthood. Figure 2.2 below illustrates these four phases, namely: the reflexive movement phase, the rudimentary movement phase, the fundamental movement phase and the sport-related movement phase.

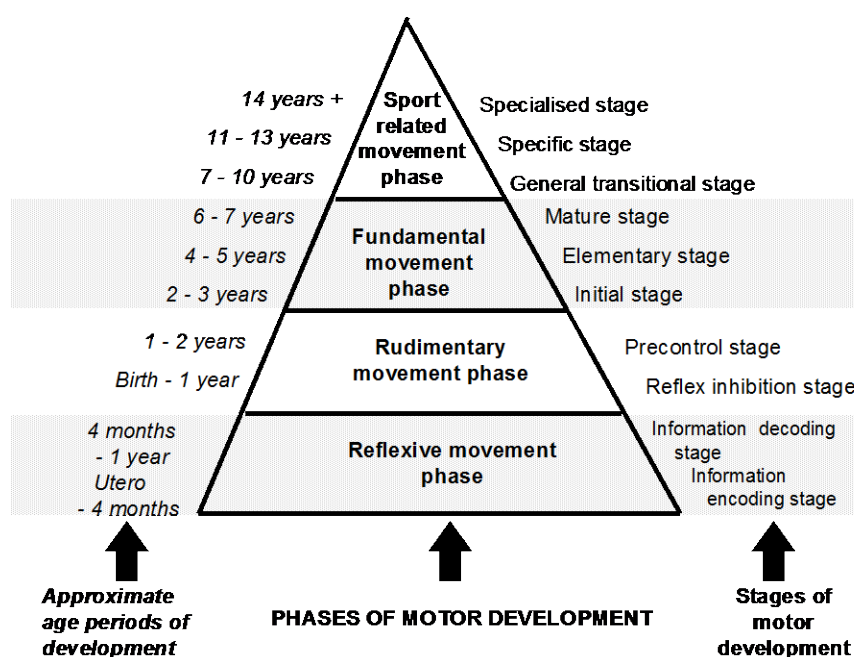


Figure 2.2: General and specific phases of motor development (Gallahue & Ozmun, 2006:49; Pienaar, 2010:126)

The reflexive phase starts in utero and continues until the child is one year of age (see fig. 2.2). Movement during this phase is a good example of the immaturity of the central nervous system. Babies, however, are born with an inherent need to move, but the movement at this stage takes place in the form of reflexes. This phase develops together with the rudimentary movement phase (Gabbard, 2008:14; Pienaar, 2010:127). The rudimentary phase starts at birth and continues until 2-years of age. Fundamental skills which include

locomotor (crawling and walking), stability (control over body during sitting and walking activities) and manipulation (reach and grasp) skills develop during this phase. This phase is critical to the development of the fundamental and sport-related movement phase (Gabbard, 2008:14; Pienaar, 2010:127).

The fundamental movement phase starts at 2-years of age and continues until 7 years. This phase is important for motor development and is critical for the development and refining of the locomotor, stability and manipulation skills which started during the previous phase. According to Siahkouhian *et al.* (2011:1358) the fundamental skills include locomotor skills such as running, galloping, hopping, horizontal jumping and object control skills such as striking, catching, kicking and overhand throwing.

The sport-related movement phase starts at 7-years and continues throughout adulthood. The main characteristic of this phase is that fundamental skills are further refined and expanded (Gabbard, 2008:14; Pienaar, 2010:140). The mastering of specialized movement skills allows children to participate in sport activities (Pienaar, 2010:140), which include those fundamental object control skills from the previous phase. This phase consists of three consecutive stages which include the transitional, application and specializing stage. During the transitional stage (7-10 years), fundamental skills are refined and combined with more sport-specific skills. Fundamental skills such as overhand throwing, becomes a sport-specific skill such as the bowling action in cricket. After the transitional stage, children move into the application stage (11-13 years) where they start making decisions as to which sport they want to participate in and then focus all their energy on this sport. The last phase, the specializing stage, starts at 14-years and continues into adulthood. During this stage there is specialization according to each individual's abilities, interest and availability of facilities and coaches (Gabbard, 2008:14; Pienaar, 2010:140).

Participation in sport and physical activity is dependent on exercising the necessary skills (Barton *et al.*, 1999:9). If the child masters the fundamental motor skills, and moves into the sport-related movement stage, it will lead to increased self-confidence and active participation in specialized movement skills and sport and will, in turn, lead to lifelong participation in sport (Lee *et al.*, 1995:384; Rose *et al.*, 1994:18).

2.6 Object control skill problems

Delays or problems with object control skills could lead to negative outcomes with regard to academic and sport skills. These possible problems will be discussed accordingly.

2.6.1 Academic-related movement problems

Miletic *et al.* (2003:53) argue that FMS must be developed as early as possible, preferably during the primary school years. Mastery of FMS has to take place in order for the development of higher-level skills to take place. Researchers report that there are a strong link between motor functioning and academic performance (Bart *et al.*, 2007:599). Children with motor problems, will move slow and carefully, and will not participate in gross motor activities necessary for school activities such as social play and physical education classes (Cools *et al.*, 2008:154). A study by Westendorp *et al.* (2011:2773) compared 7-12 year old children with learning disabilities (n=104) to typically developed children (n=104). They found that the children with learning disabilities, showed a relationship between reading and locomotor skills and a similar relationship found between mathematics and object control skills. These researchers reported that the larger the children's learning predisposition was, the poorer their results were regarding their motor skills. Another study conducted by Westendorp *et al.* (2014:414), on the effect of a ball skill intervention on the cognitive function on a selected group of children, found that as the ball skills improved, so did their cognitive functions.

2.6.2 Sport-related movement problems

Butterfield *et al.* (2012:261) reported that children who had a sound FMS, had the equipment to be physically active. In this regard Stodden *et al.* (2008:301) concluded that children who were motor competent were more involved in physical activity, and more specifically in sports.

FMS are, according to Payne and Isaac (1995:300), the foundation of specific skills, used in adult physical activity. Due to this it is assumed that there exists a relationship between a child's participation in physical activity and his/her mastery of FMS. Ulrich (1987:2) reported a definitive relationship between motor proficiency and physical activity,

namely organized sport in children in Grades K-4. A study by Okely *et al.* (2001:1902) found that the ability to perform FMS was related to their participation in physical activity.

Exceptional sport performance relies on using all the visual information. Due to this fact there is a growing belief that perceptual skills antedate and control skilful action in sport (Harris & Jenkins, 1998:8). Gender may also be a factor related to object control skills and will be discussed.

2.7 The effect of gender on object control skills

Usually differences in FMS become more apparent during the pre-school period. Researchers (Burton & Miller, 1998:335; Goodway *et al.*, 2010:22) found that girls usually performed better than boys during motor actions, which required precision such as: drawing, typing and tapping. Burton and Miller (1998:335) also found that girls performed better during reaction speed activities while boys on the other hand had an advantage during running, jumping and punching activities. Bruininks and Bruininks (2005:54) found similar results where girls were also better in motor actions that required precision and ambidexterity. In contrast with the above-mentioned studies Hardy *et al.* (2010:505) found in their study of 425 children in Australia, that girls tended to have better locomotor skills and boys better object control skills. Different from the above-mentioned study, Spessato (2012:916) found that the boys performed better during the locomotor skills, compared to girls.

According to the Booth *et al.* (2006:96) longitudinal study in Sydney with 5500 children ranging from 5-16 years, boys presented a five times higher mastery in the kicking skill compared to the girls. During overhand throw the boys again achieved a higher mastery than the girls. Lastly in catching a ball both genders did very well, although the boys once again had a higher mastery during the duration of the whole study, while the girls only fared very well during one year. Krombholz (1997:1168) found meaningful performance differences between boys and girls, in his study of 590 Brazilian children aged 3-10 years, where the boys performed better than the girls during the object control skills. In contrast with the above-mentioned study Du Toit's (2001:86) study on 136 children (67 boys and 69 girls), aged 3-6 years, found no statistically significant differences between the object control skills of boys and girls.

2.8 The effect of socio-economic status on object control skills

Researchers indicate that the environment, in which children grow up in, can play a significant role in their motor development. This role becomes increasingly bigger as the children grow up and is subjected to their environment (Lejarraga *et al.*, 2002:54). Goodway and Branta (2003:36) indicated that underprivileged children showed developmental delays with regard to their fundamental skills. A study by Robinson and Goodway (2009:539) indicated that motor delays could develop due to the poor environment that children in disadvantaged communities lived in, and that these children were prone to develop poor motor comprehension.

In their study on 67 South African children Uys and Pienaar (2010:140) found that children in the low socio-economic group performed poor compared to the high socio-economic status regarding motor development. The Booth *et al.* longitudinal study (2006:111) reported no consistent relationship between socio-economic status and kicking proficiency. These researchers indicated that when girls turned 8 years the prevalence of advanced skills was significantly lower when taking socio-economic status into account. These girls also showed a direct relationship between socio-economic and throwing proficiency. In the catching skill for the boys there were different results for the period of the study. For the first and second last year of the study, the proficiency of throwing increased as socio-economic status increased, but during the last year it decreased as socio-economic status increased. The results of the girls were more consistent. Their catching proficiency increased as the socio-economic status increased.

Children from low a socio-economic status usually have little access to organized sport and physical activity, especially those who require expensive equipment or lessons and extensive time from their parents (Haywood & Getchell, 2005:204). Lotz *et al.* (2005:64) also found that motor development could be delayed if children lived in poor socio-economic environments. Reasons for this delay might be inadequate stimulation and remediation (Lotz *et al.*, 2005:66).

2.9 The relation between visual-motor integration, visual perception and motor co- ordination problems and object control skills

Researchers (Cheatum & Hammond, 2000:277; Pienaar, 2010:310; Willoughby & Polatajko, 1995:789) indicated that the development of motor skills, that included co-ordination (hand-eye and foot-eye), were dependent on the visual systems functioning effectively and good eye muscle control. Bonifacci (2004:164) on the other hand states that poor performance in motor skills is not necessarily associated with problems in the visual perceptual abilities. Tsai *et al.* (2008:659) supports this finding by stating that visual perception shortcomings and motor tasks may be task-specific and does not necessarily have an interrelationship.

According to several researchers, motor delays are not only caused by gross motor delays but are also due to inadequate eye functioning (Bouchard & Tetreault, 2000:564; Cheatum & Hammond, 2000:277; Desrochers, 1999:36; Pienaar, 2010:310; Van Hof-Van Duin *et al.*, 1998:302; Winnick, 2005:369). Lowry and Hatton (2002:125) confirm this by saying that milestone development is directly influenced by visual abilities. Visual information is especially important for regulating proprioceptive decisions of limb positioning, in other words deciding where the arms and legs must go in order to perform the required action (Mon-Williams *et al.*, 1999:247; Horowitz & Röst, 2007:68).

A child who struggles with spatial problems will experience problems with discrimination between objects due to their place in the space. These children will also struggle to plan their actions around objects and this could lead to gross motor delays. Poor depth perception can affect a child's ability to walk through tight spaces or to catch a ball, these children find it difficult to predict when the playing surface changes and to climb steps or identify changes in direction (Cheatum & Hammond, 2000:295).

As previously mentioned figure-ground perception and spatial orientation are two important components when performing on the sports field (Winnick, 2005:287). Problems with figure- ground perception will prevent a child from seeing an on-coming ball. This will cause the child not to be able to track a ball, to hit or kick a ball (Winnick, 2005:367). Spatial orientation, posture, body awareness and balance depend on good visual skills to perform in different sports (Cheatum & Hammond, 2000:263).

Bonifacci (2004:164) found a significant difference in the visual-motor integration skills

between children with low and high gross motor skills in his study of 141 Brazilian children, aged 6-10 years. Wilson and Falkel (2004:11) indicated that good co-ordination between the hands and eyes is necessary for sports such as basketball, volleyball and baseball and they also highlighted the importance of foot-eye coordination in order to get into the best position to perform a hand-eye co-ordination task. Wilson and McKenzie (1998:835) also indicated that defects in treatment of the visual signals at different points could lead to problems in movement planning, movement correction and feedback control. According to Wilson and Falkel (2004:10) part of visual perception in sport included an athlete being able to focus on the ball, whilst keeping the different positions of his teammates as well as the position of the opposition in mind, while not paying attention to any outside distractions. Wilson and McKenzie (1998:835) found that problems with visual components such as visual perceptual skills were associated with problems in motor co-ordination. Tepeli (2013:50) found in his study of 322 children, ranging from 54 to 59 months, from the central province of Kenya, that the children's visual perception skills improved as their gross motor skills (locomotor- and object control skills) improved, and conversely, if their visual perception skills decreased, so did their gross motor skills.

Motor co-ordination, plays a crucial role in activities where hand-eye and foot-eye co-ordination is important, especially in sports such as rugby, hockey, netball and soccer, where a ball has to be kicked, hit or caught, while paying attention to your opponent (Cheatum & Hammond, 2000:263). Wilson and Falkel (2004:11) found that if children's eyes were unable to move quickly and efficiently, they would not be able to perform well in sports. They also found that the difference between good and elite cricket and soccer players, when their physical skills were equal, the elite players were able to move their eyes more efficiently (Wilson & Falkel, 2004:11). Wilson and Falkel (2004:10) also stress the importance of the integration of visual perception and motor coordination to be able to perform unforeseen movements on the sport field.

2.10 Summary

The aim of the literature review was to provide an overview of the visual system, terminology regarding the visual system, visual-motor integration, visual perception and motor co-ordination. The visual system anatomy, the sensory systems involved in vision, the incidence, symptoms and consequences of visual problems and lastly the possible effect that gender and socio-economic status could have on the three main visual skills, namely

visual-motor integration, visual perception and motor co-ordination, were then discussed. Secondly object control skills were investigated, with regard to relevant terminology, consequences, both academic and sport-related, due to movement problems, the effect of gender and socio-economic status on object control skills and lastly the influence of visual-motor integration, visual perception and motor co-ordination skills on object control skills was discussed.

This literature review revealed significant academic and movement-related problems, due to poor visual-motor integration, visual perception and motor co-ordination skills. Furthermore, the effect or influence of visual-motor integration, visual perception and motor co-ordination on object control skills also seems important to investigate further, due to the effect it may have on the development of sport skills.

With regard to the effect of gender and socio-economic status on visual-motor integration, visual perception, motor co-ordination and object control skills, controversy still exists, due to researchers' different findings. The effect that socio-economic status, or in fact poor socio-economic status, can have on these skills is more apparent and seems to have a significant role in the lack of development in these skills. For this reason it should be very important to study these effects, in order for us to come up with prevention plans for education providers.

With this literature review as background, Chapter 3 and 4's results will be discussed accordingly.

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CHAPTER 3



Influences of gender and socio-economic status on visual-motor integration, visual perception and motor coordination in Grade 1-learners: the NW-CHILD study

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Running head: Gender, socio-economic status and visual-motor integration, visual perception and motor co-ordination

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Influences of gender and socio-economic status on visual-motor integration, visual perception and motor co-ordination in Grade 1-learners: the NW-CHILD study**ABSTRACT:**

The aim of this study was to determine to what extent gender and socio-economic status influenced visual-motor integration, visual perception and motor co-ordination in Grade 1-learners in the North West Province of South Africa. The baseline measurements of the NW- CHILD longitudinal study were used, and a total of 816 Grade 1-learners (419 boys and 397 girls) with a mean age of 6.78 years ($SD=0.49$), from Quintile 1 – Quintile 5 schools (1 = low socio-economic and 5 = high socio-economic) were tested. The Developmental Test of Visual-Motor Integration 4th ed. (VMI-4) was used to evaluate visual-motor integration, visual perception and motor co-ordination skills. Descriptive statistics were used to describe each test variable and an ANOVA was used to determine the interaction of gender differences and socio- economic status in visual-motor integration, visual perception and motor co-ordination. The results indicated that gender had no significant effect on visual-motor integration, visual perception and motor co-ordination within the respective school types. Although there were no significant differences between the boys and girls, tendencies of a higher mean standard scores were found in higher Quintile schools (4 and 5) regarding visual-motor integration, visual perception and motor co-ordination, compared to children in the lower Quintile schools (1 to 3). Socio-economic status however had a significant effect ($p=0.001$) on visual-motor integration, visual perception and motor co-ordination in boys and girls respectively. These baseline results enable us to educate teachers, especially in lower socio-economic circumstances, to make age- appropriate movement plans, which may improve academic and sport results.

Keywords: gender; socio-economic; visual-motor integration; visual perception; motor co-ordination

Influences of gender and socio-economic status on visual-motor integration, visual perception and motor coordination in Grade 1-learners: the NW-CHILD study

3.1 INTRODUCTION

Visual-motor integration refers to the ability to use visual information detected by the eyes and to convert it into a motor output (Weil & Cunningham-Amundson, 1994). Researchers indicate that visual-motor integration is a corner stone to the development of academic skills and learning aptitude (Daly, Kelley & Krauss, 2003; Dickerson Mayes & Calhoun, 2003; Salvia & Ysseldyke, 1998; Sortor & Kulp, 2003; Taylor-Kulp, 1999), and is further important for learning skills such as writing, typing on a keyboard and throwing or catching a ball (Katz & Hartmann-Maier, 2005, Scheiman, 2002, Taylor-Kulp & Sortor, 2003). Deficits in visual-motor integration skills have been identified as a possible cause of learning disabilities later in life (Taylor-Kulp, 1999). Many studies recognize that visual functioning problems can debilitate children in their school work, more specific, reading, writing and learning (Auxter, Pyfer & Huettig, 1997; Cheatum & Hammond, 2000; Pienaar, Barhorst & Twisk, 2013). Visual-motor integration also refers to co-ordinating body movements with visual perception (Cornhill & Case-Smith, 1996; Scheiman, 2002).

Visual perception refers to the ability to organize and make sense from information received through the eyes (Taylor-Kulp & Sortor, 2003). These skills need to be assessed regularly since deficits in these skills are positively associated with learning readiness and academic achievement in reading, math and writing (Taylor-Kulp, 1999). According to Winnick (2011), visual perception is essential to motor movement because it plays such an important role in catching, throwing, kicking, running and other fundamental skills.

Motor co-ordination refers to the ability to use vision and different body actions interactively (Winnick, 2011). Two important components of motor co-ordination are hand-eye (involves using the eyes and hands to perform a motor activity) and foot-eye (involves using the eyes and feet to perform a motor activity) co-ordination (Crawford, Medendorp & Marotta, 2004; Winnick, 2011). In general, motor co-ordination problems are prominent in children with learning disorders (Taylor-Kulp, 1999) and non-verbal learning disorders. These children especially show significant deficits in visual-spatial and visual-perceptual abilities (Taylor-Kulp, 1999). Motor co-ordination plays an important role in sports such as rugby, netball and soccer (Cheatum & Hammond, 2000).

Studies indicate that educational level, socio-economic status and culture can effect visual perceptual development and subsequently learning, school success, life skills and social skills could also be affected by poor visual perception (Baard, 1998; Delgado-Gaitan, 1992; Dunn, 2001; Eccles & Harold, 1993; Hoover-Dempsey, Bassler & Brissie, 1987; Lareau, 1987; Pena, 2000).

Motor development can be delayed if children live in disadvantaged communities (Craig, 1996), due to unsuitable learning opportunities at home or school, poor living circumstances and poor health (Sherill, 2004). Studies by Baard (1998), Dunn (2001) and Kagiticibasi (1979) indicated that socio-economic status could predict visual-motor integration. A study by Lotz, Loxton and Naidoo (2005) investigated the visual-motor integration functioning in a South African population living in the Stellenbosch region, which included 339 children (171 males and 168 females) in Grades 1 to 4. These researchers found that visual-motor integration increased with improved socio-economic status (SES) while cognitive function had an effect on language, visual perception, visual-spatial relations and memory (Lotz et al., 2005). Ercan, Ahmetoğlu and Aral (2011), in their study of 178 children in Edirne, investigated the visual-motor integration skills of 60-72 months old children in high and low SES. These researchers reported higher mean scores among children in higher socio-economic status compared to children from a lower SES (Ercan et al., 2011). Ercan et al. (2011) further reported significant differences in the visual-motor integration and motor co-ordination with regards to SES, although no significant difference was found in the visual perception test. Socio-economic status therefore seemed to play an important role in the visual- motor development, which included the visual-motor integration and motor co-ordination skills of boys and girls.

There is still some controversy in the literature regarding gender differences with regard to visual-motor integration, visual perception and motor co-ordination. Pienaar et al. (2013), in their study of 812 Grade 1 children (418 boys and 394 girls) in the North West Province of South Africa, found that visual-motor integration and visual perception was highly significant for mastery in math, reading and writing. These researchers also established that SES was related to academic success, where lower socio-economic status predicted poorer academic results ($p < 0.01$) and girls tended to do better than the boys in academic performance. Lotz et al. (2005) indicated that SES could be an important predictor of visual-motor skills, and that girls might even be more at risk for gross motor developmental

delays than boys if their visual-motor integration skills were poor. Tekok-Kilic, Elmastas-Dikec and Can (2010) however

reported no gender differences in visual-motor integration among different age groups (6- to 15 years) that they tested. Aylward and Schmidt (2001) also found no gender differences in their study of 103 children (55 boys and 48 girls), ranging from 5 to 6 years, with regards to visual- motor integration, visual perception and motor co-ordination. However several older studies (Brown, 1990, Harris, 1963) did find the girls to be superior to the boys with regards to visual- motor integration skills.

From the literature it is clear that visual-motor integration, visual perception and motor co- ordination play an important role in academic skills, sporting activities and everyday life. Clear controversy exists in the literature about gender differences within different socio-economic status with regards to visual-motor integration, visual perception and motor co-ordination. The debilitating effect that poor socio-economic status could have on visual-motor integration, visual perception and motor co-ordination has been researched, however, research in the South African milieu and the further effect of gender have not particularly been investigated. Investigating these relationships will shed light on the potential role that visual-motor integration, visual perception and motor co-ordination could have on academic outcomes and sport performance of children, and may contribute to the development of age-appropriate motor skills development plans which could improve academic and sport skills.

3.2 MATERIAL AND METHODS

3.2.1 Research design

This study is based on a longitudinal study design (NW-CHILD study) which spans over a period of six years (2010-2016). It includes three sequential measurements which consist of the baseline and two follow-up measurements, although only the baseline data (2010) was used for this particular study. Therefore a one-time cross sectional design was used.

3.2.2 Participants

The research formed part of the Child-Health-Integrated-Learning and Development (NW-CHILD) study. The target population for this study was Grade 1-learners of the North West Province of South Africa. The total number of participants identified for the study was 880 Grade 1-learners. The research group was selected by means of a stratified

random design in conjunction with the Statistical Consultation Services of the North-West University. To determine the research group, a list of names of schools in the North West Province was obtained from the Educational Department of the North West Province. This list of schools was grouped in 4 educational districts, each representing 12 – 22 regions with approximately 20 schools (minimum 12, maximum 47) per region. Regions and schools were randomly selected with regards to population density and school status (Quintile 1, i.e. schools from poor economic sectors to Quintile 5, i.e. schools from well-off economic sectors). Boys and girls in Grade 1 was then randomly selected from each school. A total of 20 schools from 4 districts were involved in the study, with a minimum of 40 children per school and with an even gender distribution. The total group consisted of 816 learners (419 boys and 397 girls) with a mean age of 6.78 years (SD). Quintile 1 schools consisted of 79 boys and 76 girls, quintile 2, 84 boys and 75 girls, quintile 3, 84 boys and 91 girls, quintile 4, 83 boys and 71 girls and quintile 5, 89 boys and 84 girls.

3.2.3 Measuring instruments

Developmental Test of Visual-Motor Integration – 4th edition – Test battery (VMI-4)

The Developmental Test of Visual-Motor Integration – 4th ed. (VMI-4) (Beery & Buktenica, 1997) consists of the visual-motor integration test and two subtests, which include visual perception and motor co-ordination. The aim of the VMI-4 is to identify children who need special assistance, by means of early detection. The complete 27-item-VMI can be administered individually or in groups. It takes about 10-15 minutes to complete, and can be used from pre- school children to adults. The visual-motor integration subtest consists of a list of consecutive geometrical shapes which have to be drawn with a pencil on paper. This test allows 10 minutes to be completed or is stopped after 3 consecutive mistakes. The visual perception subtest requires matching shapes with each other and takes 3 minutes to complete or until 3 consecutive mistakes are made. The last subtest, motor co-ordination, involves completing dots in a shape and takes 5 minutes to complete. The criteria for awarding marks on the VMI-4 are as follows: a “0” is awarded for figures that are wrong and a “1” is awarded for the correct figures. The data is captured under three categories: visual-motor integration, visual perception and motor co- ordination. The raw score is converted to a standard score, and then to a percentile. Using the standard score, children can be grouped into five different classes, ranging from very high (133- 160), high (118-132), average (83-117), low (68-82) to very low (40-67). The VMI-4 was developed to measure the extent to which an individual can integrate his visual and

motor capabilities. The VMI-4 subtests have a validity of 0.92, .091 and 0.89 respectively (Beery & Buktenica, 1997).

3.2.4 Procedure

3.2.4.1 Research procedure

Ethical approval was obtained from the Ethics Committee of the North-West University, Potchefstroom Campus (No. NWU-0070-09-A1), as well as from the Department of Basic Education of the North West Province. A formal meeting was organized with each principal, where the aim and protocol of the study were explained, and permission was asked for collecting data during school hours. Trained interpreters were used to convey the instructions of the evaluators to the subjects, if English was not their first language. If the numbers of learners in the school allowed it, 60 Grade 1-learners were randomly selected and received informed consent forms that had to be completed by their parents/guardians. This was done to ensure that informed consent would be granted by the parents/guardians for a minimum of 40 learners who needed to be measured at each school. The learners, whose parents reacted positively to the above-mentioned forms, underwent the tests. In the total study thirteen parents (1.5%) did not consent to participation, whereas 35 (4.0%) of the selected participants were absent at school on the day of testing or had to be excluded due to incorrect ages that were provided by the schools.

3.2.4.2 Statistical procedure

Data analysis was done with the STATISTICA software package (StatSoft, 2013). Firstly, descriptive statistics (mean (M), standard deviations (SD), minimum and maximum values) of each variable were calculated. Secondly, ANOVA was used to determine the interaction effect between gender/socio-economic status and visual-motor integration, visual perception and motor co-ordination. Thirdly, an independent t-test was used to determine the effect of gender differences and socio-economic status in visual-motor integration, visual perception and motor co-ordination. Lastly, two-way frequency tables were used to compare the classifications of the different quintiles among the VMI-classes. The Pearson Chi-square was used to indicate the significance of the differences and the level of statistical significance was set at $p \leq 0.05$. The strength of the relationship was indicated by phi-coefficient, with $w \approx 0.1$ indicating a small effect, $w \approx 0.3$ a medium effect and $w \geq 0.5$ a large effect.

3.3 RESULTS

Table 3.1 shows the characteristics of the group by gender, age and socio-economic status. A total of 419 boys and 397 girls were identified as participants for this study. The group had a mean age of 6.78 years ($SD = 0.49$), with the boys having a slightly higher mean age of 6.81 years ($SD = 0.49$), compared to the girls' mean age of 6.74 years ($SD = 0.48$). Table 3.1 also displays the number of participants in each quintile school, divided by gender. Slightly more boys were in the Quintile 5 compared to Quintile 1 schools, whereas Quintile 3 had the highest number of girls and Quintile 4 the least.

TABLE 3.1: CHARACTERISTICS OF THE GROUP BY GENDER, AGE AND SOCIO- ECONOMIC STATUS

Study participants	Quintile N)					Total group	M	SD	Age (years)	
	1	2	3	4	5				Minimum	Maximum
Boys	79	84	84	83	89	419	6.81	0.49	6.00	7.80
Girls	76	75	91	71	84	397	6.74	0.48	6.00	7.80
Total	155	159	175	154	173	816	6.78	0.49	6.00	7.80

N= number of participants; M=mean; SD=standard deviation

Table 3.2 indicates the possible effect of SES by gender and the interaction of gender and socio-economic status on visual-motor integration, visual perception and motor co-ordination. No statistical interaction effect was found ($p \geq 0.05$). There were also no statistically significant gender effect for visual-motor integration, visual perception and motor co-ordination. However, a statistically significant ($p \leq 0.05$) SES effect (as measured by different quintiles) with regards to visual-motor integration, visual perception and motor co-ordination was found. Due to no statistically significant interaction between gender and visual-motor integration, visual perception and motor co-ordination, only socio-economic status and its association with visual- motor integration, visual perception and motor co-ordination will be discussed.

TABLE 3.2: EFFECT OF GENDER AND SOCIO-ECONOMIC STATUS ON VISUAL- MOTOR INTEGRATION, VISUAL PERCEPTION AND MOTOR COORDINATION

Effect	VMI	VP	MC
	p-value	p-value	p-value
Intercept	$\leq 0.001^*$	$\leq 0.001^*$	$\leq 0.001^*$
Quintile (SES)	$\leq 0.001^*$	$\leq 0.001^*$	$\leq 0.001^*$
Gender	0.152	0.211	0.436
Quintile (SES)*Gender	0.156	0.875	0.270

VMI = visual-motor integration; VP = visual perception; MC = motor coordination; significant differences = $p \leq 0.05^*$; SES = socio-economic status

In Table 3.3 the results of an ANOVA are displayed to determine the possible effect of socio- economic status, in visual-motor integration, visual perception and motor co-ordination skills in boys and girls. From this table it is evident that, with regards to boys, there is a statistically significant ($p < 0.001$) interaction between socio-economic status and visual-motor integration, visual perception and motor co-ordination. Similar results were found with regard to the girls, where a statistically significant ($p < 0.001$) interaction between socio-economic status and visual-motor integration, visual perception and motor co-ordination was also found.

TABLE 3.3: EFFECT OF SOCIO-ECONOMIC STATUS ON VISUAL-MOTOR INTEGRATION, VISUAL PERCEPTION AND MOTOR COORDINATION IN BOYS AND GIRLS

Quintile	1	2	3	4	5	MSE	p
	M SS	M SS	M SS	M SS	M SS		
Boys							
VMI	87.14 ^(2,4-5)	85.99 ^(1,4-5)	87.67 ⁽⁴⁻⁵⁾	97.98 ⁽¹⁻³⁾	95.65 ⁽¹⁻³⁾	161	<0.001*
VP	68.90 ⁽⁴⁻⁵⁾	68.80 ⁽⁴⁻⁵⁾	68.35 ⁽⁴⁻⁵⁾	94.18 ⁽¹⁻³⁾	92.22 ⁽¹⁻³⁾	389	<0.001*
MC	92.85 ^(2,4-5)	86.96 ^(1,4,5)	86.73 ⁽⁴⁻⁵⁾	99.04 ⁽¹⁻³⁾	97.42 ⁽¹⁻³⁾	194	<0.001*
Girls							
VMI	91.66 ^(2,4-5)	83.69 ^(1,4-5)	87.75 ⁽⁴⁻⁵⁾	100.85 ⁽¹⁻³⁾	96.86 ⁽¹⁻³⁾	161	<0.001*
VP	71.93 ⁽⁴⁻⁵⁾	68.15 ⁽⁴⁻⁵⁾	71.41 ⁽⁴⁻⁵⁾	94.65 ⁽¹⁻³⁾	94.98 ⁽¹⁻³⁾	389	<0.001*
MC	91.04 ^(2,4-5)	87.83 ^(1,4-5)	90.79 ⁽⁴⁻⁵⁾	97.56 ⁽¹⁻³⁾	99.58 ⁽¹⁻³⁾	194	<0.001*

VMI=visual-motor integration, VP=visual perception; MC=motor coordination; MSS=Mean standard score MSE=Mean score error; $p \leq 0.05^*$; Quintile 1=lowest income; Quintile 5=highest income, Upper script indicates a statistical difference between classes.

Table 3.3 indicates that boys and girls in Quintile 4 and 5 schools obtained higher mean

standard scores compared to learners in Quintile 1-3 schools in all the skills. The results further shows that the boys in Quintile 4 and 5 (high socio-economic status) schools received significantly higher mean scores in visual-motor integration (M=97.98 and M=95.65), visual perception (M=94.18 and M=92.22) and motor co-ordination (M=99.04 and M=97.42) compared to Quintile 1-3 (low socio-economic status) schools. The same tendency was found for the girls, where the girls in Quintile 4 and 5 schools received higher mean scores in visual-motor integration (M=100.85 and M=96.86), visual perception (M=94.65 and M=94.98) and motor co-ordination (M=97.56 and M=99.58) than girls in Quintile 1-3 schools.

A two-way summary table was further compiled to compare the percentage of participants classified in each visual-motor integration, visual perception and motor co-ordination class (ranging from very high to very low) in the different Quintile schools (1-5) and the results are displayed in Table 3.4a (boys) and 3.4b (girls). Table 3.4a indicates that the highest percentage of boys was classified in Class 3 (average class) in all Quintile schools with regards to visual- motor integration. No participants were classified in Class 1 (0%), while one participant (1.20%) of Quintile 4 schools was in Class 1 (Very High). There was a statistical ($p < 0.001$) and practical ($w = 0.32$) significance between the various visual-motor integration classes and the socio- economic status of the different Quintile schools. Visual perception differences indicate that boys in Quintile 1-3 schools were mostly classified (40.51%, 44.05% and 46.43%) in Class 5 (very low), while Quintile 4 and 5, again had the highest percentage of participants in Class 3 (average) (60.24% and 60.67%) respectively. There were no boys classified in Class 1 (Very high) in Quintile 1-4 schools, but there was only 2.25% ($n = 2$) boys in Class 1 from in Quintile 5 schools. Again a statistically significant difference ($p < 0.001$) with a high practical ($w = 0.58$) effect was found between socio-economic status and the different visual perception classes. Motor co-ordination showed the same tendencies as visual-motor integration, with the highest percentage of boys being classified in the average category, in Quintiles 1-5 schools. There were no boys in Class 1 (very high) (0.00%) in Quintiles 1-5 schools. Motor co-ordination was statistically significant ($p < 0.001$) with a medium practical ($w = 0.32$) effect between the different socio- economic status schools.

TABLE 3.4a: PERCENTAGE OF BOYS CLASSIFIED IN DIFFERENT CATEGORIES OF MASTERING FOR VMI, VP AND MC BY SOCIO-ECONOMIC SCHOOL TYPE

Variables	Class 1		Class 2		Class 3		Class 4		Class 5		Pearson Chi-Square p	Phi- coefficient w	
	Very High		High		Average		Low		Very Low				
	N	%	n	%	n	%	n	%	n	%	n		
Visual-motor integration													
Quintile 1	79	0.00	0	0.00	0	73.42	58	20.25	16	6.33	5	0.001*	0.32[#]
Quintile 2	84	0.00	0	1.19	1	59.52	50	32.14	27	7.14	6		
Quintile 3	84	0.00	0	1.19	1	69.05	58	22.62	19	7.14	6		
Quintile 4	83	1.20	1	2.41	2	86.75	72	9.64	8	0.00	0		
Quintile 5	89	0.00	0	4.49	4	85.39	76	7.87	7	2.25	2		
Visual Perception													
Quintile 1	79	0.00	0	0.00	0	22.78	18	36.71	29	40.51	32	0.001*	0.58^{##}
Quintile 2	84	0.00	0	1.19	1	11.90	10	42.86	36	44.05	37		
Quintile 3	84	0.00	0	0.00	0	23.81	20	29.76	25	46.43	39		
Quintile 4	83	0.00	0	10.84	9	60.24	50	27.71	23	1.20	1		
Quintile 5	89	2.25	2	7.87	7	60.67	54	21.35	19	7.87	7		
Motor Coordination													
Quintile 1	79	0.00	0	0.00	0	82.28	65	13.92	11	3.80	3	0.001*	0.32[#]
Quintile 2	84	0.00	0	0.00	0	70.24	59	20.24	17	9.52	8		
Quintile 3	84	0.00	0	0.00	0	67.86	57	23.81	20	8.33	7		
Quintile 4	83	0.00	0	2.41	2	95.18	79	1.20	1	1.20	1		
Quintile 5	89	0.00	0	3.37	3	86.52	77	8.99	8	1.12	1		

Very high= Class 1; High=; Class 2; Average= Class 3; Low =Class 4; Very low=Class 5; Quintile 1=lowest income; Quintile 5=highest income, n=number of participants; $p \leq 0.05^*$; $w > 0.3^{\#}$; $w > 0.5^{\#\#}$

TABLE 3.4b: PERCENTAGE OF GIRLS CLASSIFIED IN DIFFERENT CATEGORIES OF MASTERING FOR VMI, VP AND MC BY SOCIO-ECONOMIC SCHOOL TYPE

Variables	Class 1		Class 2		Class 3		Class 4		Class 5		Pearson Chi-Square p	Phi- coefficient w	
	N	Very High %	n	High %	n	Average %	n	Low %	n	Very Low %			n
Visual-motor integration													
Quintile 1	76	0.00	0	2.63	2	81.58	62	14.47	11	1.32	1	0.001*	0.45^{###}
Quintile 2	75	0.00	0	4.00	3	50.67	38	30.67	23	14.67	11		
Quintile 3	91	0.00	0	0.00	0	64.84	59	29.67	27	5.49	5		
Quintile 4	71	2.82	2	9.86	7	80.28	57	7.04	5	0.00	0		
Quintile 5	84	0.00	0	2.38	2	88.10	74	9.52	8	0.00	0		
Visual Perception													
Quintile 1	76	0.00	0	2.63	2	26.32	20	36.84	28	34.21	26	0.001*	0.60^{###}
Quintile 2	75	0.00	0	0.00	0	5.33	4	57.33	43	37.33	28		
Quintile 3	91	0.00	0	0.00	0	26.37	24	38.46	35	35.16	32		
Quintile 4	71	2.82	2	14.08	10	50.70	36	22.54	16	9.86	7		
Quintile 5	84	0.00	0	5.95	5	70.24	59	19.05	16	4.76	4		
Motor Coordination													
Quintile 1	76	0.00	0	1.32	1	76.32	58	14.47	11	7.89	6	0.015*	0.28[#]
Quintile 2	75	0.00	0	0.00	0	76.00	57	14.67	11	9.33	7		
Quintile 3	91	0.00	0	0.00	0	80.22	73	12.09	11	7.69	7		
Quintile 4	71	0.00	0	5.63	4	81.69	58	11.27	8	1.41	1		
Quintile 5	84	2.38	2	3.57	3	88.10	74	4.76	4	1.19	1		

Very high= Class 1; High=; Class 2; Average= Class 3; Low =Class 4; Very low=Class 5; Quintile 1=lowest income; Quintile 5=highest income, n=number of participants; p≤0.05; w>0.1*; w>0.3**; w>0.5*****

Table 3.4b indicates that the girls in Quintile 1-5 schools were mostly classified in Class 3 (average) for visual-motor integration. No girls from Quintiles 1-3 and 5 schools were classified in Class 1 (very high), however there were 2.82% (n=2) girls from Quintile 4 schools in Class 1. There was a statistical ($p<0.001$) and practical significant effect ($w=0.45$) between the various visual-motor integration classes and the different socio-economic statuses of the schools. During visual perception the girls from Quintile 1-3 schools were mostly classified in Class 4 (low), while the girls from Quintile 4 and 5 schools were mostly classified in Class 3 (average). Only 2.82% (n=2) girls from Quintile 4 schools were in Class 1 (very high). Again a statistically significant difference ($p<0.001$) with a large practical ($w=0.60$) effect was found between socio-economic status and the different visual perception classes. Motor co-ordination had the same tendencies as visual-motor integration, with the most girls classified in Class 3 (average), for all the Quintile schools. Motor co-ordination had a statistically significant difference ($p<0.015$) with a small practical ($w=0.28$) significance with socio-economic status.

3.4 DISCUSSION

The aims of this study were to determine, firstly, whether gender influenced visual-motor integration, visual perception and motor co-ordination within the different school types associated with socio-economic status, and secondly, whether socio-economic status influenced visual-motor integration, visual perception and motor co-ordination of Grade 1-learners in the North West Province of South Africa.

No significant effect was found with regards to socio-economic status by gender and the interaction of gender and socio-economic status on the visual-motor integration status of these children. Findings reported by Aylward and Schmidt (2001) on the relationship between visual-motor integration and gender, also indicated no significant differences between 5- to 6-year-old boys and girls regarding their visual-motor integration skills. Ercan et al. (2011) and other researchers (Aral & Ayhan, 2004; Aral & Erturan, 1999; Ibişoglu, 1987; Koc, 2002; Mangir & Cagatay, 1987) also found no significant effect of gender on visual-motor integration in children. However, the results of Makhele (2005) and Lotz et al. (2005) disagreed with these studies' findings, because significant differences were found between Grade 1 to 4 boys and girls, where the boys achieved higher standard scores in visual-motor integration.

This study also indicated no significant interaction effects between gender and visual perception, nor was there any significant effect with regards to the interaction of gender and socio-economic status and visual perception. These findings support the results of Aylward and Schmidt (2001) and Ercan et al. (2011) who also report no significant gender differences in visual perception. Ahmetoglu, Aral and Ayhan (2008) on the other hand found that girls had significant higher scores than the boys regarding their visual perception skills.

The results further indicated no significant effect with regards to gender in motor co-ordination, nor was there any significant effect with regards to the interaction of gender and socio-economic status and motor co-ordination. These findings agree with that of Aylward and Schmidt (2001) and Ercan et al. (2011) who also reported no significant gender differences between boys and girls in motor co-ordination.

The results furthermore indicated that there were significant relationships between the visual- motor integration, visual perception and visual motor co-ordination, and the socio-economic status of the participants. Although there were no significant differences between the boys and girls, it could clearly be seen that children in the higher socio-economic status (Quintiles 4 and 5 schools) obtained significantly higher scores in visual-motor integration, visual perception and motor co-ordination than the participants in the lower socio-economic status (Quintiles 1-3 schools) regarding their standard scores. The findings of our study support the findings by Baard (1998), Dunn (2001) and Kagiticibasi (1979), which indicate that socio-economic status has an effect on visual-motor integration. According to Kagiticibasi (1979) reasons given may be that children in high socio-economic circumstances have a higher cognitive functioning than children in low socio-economic circumstances, due to resources to stimulate these children cognitively may be more readily available. The findings of Lotz et al. (2005) indicated that socio-economic status did not only affect visual-motor integration, visual perception and motor co-ordination negatively, but also had a negative effect on language, visual-spatial relationships and visual memory.

Literature is clear that if any deficits are present in a child's visual-motor skills when entering school, poor motor development and academic performance could suffer as a result. Therefore if poor socio-economic status could negatively affect visual-motor integration, visual perception and motor co-ordination, it will possibly contribute to academic problems.

3.4.1 Conclusion and Limitations

The results of this study firstly indicated no significant gender differences in the visual-motor integration, visual perception and motor co-ordination skills of children, aged 6 years who were in Grade 1 at the time of the study. The results however, showed that different school types, which represented different socio-economic status, had a significant effect on the visual-motor integration, visual perception and motor co-ordination skills of 6-year-old children. Children attending schools in poor socio-economic circumstances had a good chance to experience developmental delays due to this. The effect of gender was also taken into consideration in the different socio-economic statuses, although it showed no significant effect. This research further indicated that children from lower SES, would have more problems in motor co-ordination, which in turn could affect their academic and sport skills. This research gives a clear view of what visual-motor integration delays that children in poor socio-economic could suffer. The knowledge obtained through this study will, however, enable practitioners and teachers to provide assistance and intervention to children who have specific needs regarding their visual motor skills.

The study did, however, demonstrate a limitation, which should be acknowledged and which could be overcome in future research. This study only took into account SES based on school types children may be in the school due to convenience or location, future research could possibly look at SES more in depth with regard to the population. This knowledge could further be implemented by the teachers, to help with the improvement of visual-motor skills deficits, which in turn could improve the children's academic and sport performance.

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Disclaimer: Any opinion, findings and conclusions or recommendations expressed in this material are the opinion of the author(s) and therefore the NRF do not accept any liability in this regard.

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CHAPTER 4



Interrelationships between visual-motor integration, visual perception, motor coordination and object control skills of Grade 1-learners: the NW-CHILD study

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Interrelationships between visual-motor integration, visual perception, motor coordination and object control skills of Grade 1-learners: the NW-CHILD study

ABSTRACT

The aim of this study was to determine the interrelationship of visual-motor integration, visual perception, and motor co-ordination with object control skills in Grade 1-learners in the North West Province of South Africa. This study is based on a longitudinal study design (NW-CHILD study), although only the baseline data was used. Eight hundred and six Grade 1-learners with a mean age of 6.84 years, took part in this study. The Developmental Test of Visual-Motor Integration 4th ed. was used to evaluate the visual skills while the Test of Gross Motor Development-2 was used to evaluate six object control skills. There was a statistical significant ($p \leq 0.01$) association between VMI, two object control skills and the object control skills total score. Visual perception had the highest correlation with all the object control skills. Visual perception had a statistically significant ($p \leq 0.05$) association with five object control skills and object control skills total score. Motor coordination only had small significant correlations with two object control skills. These results contribute to our understanding of the influence that VMI, visual perception and motor co-ordination have on ball handling skills and enable practitioners to address them appropriately during early years, in order to improve sport skills later in life.

Keywords: visual-motor integration; visual perception; motor co-ordination, object control skills

4.1 INTRODUCTION

Visual-motor integration refers to the action of merging visual information with fine motor skills (Avi-Itzhak & Obler, 2008), and is important in the acquisition of skills such as handwriting, keyboarding and the throwing or catching of a ball (Avi-Itzhak & Obler, 2008). Fine motor skills require rigorous movements of the hands and fingers and are depended on hand-eye co- ordination to perform a task successfully (Baard, 1998; Beery & Buktenica, 1997). Deficiencies in these skills could contribute to problems pertaining to academic skills, participation in school activities and self-concept (Ercan *et al.*, 2011).

Visual-motor integration involves not only hand-eye co-ordination, but also visual perceptual skills (Pereira *et al.*, 2011). Visual-motor integration is also referred to as changing visual perception into a motor output. According to Weil and Amundson (1994), visual-motor integration is supported by skills such as visual perception, psychomotor speed and hand-eye co- ordination. Wilson and Falkel (2004) further indicate that good co-ordination between the hands and eyes are necessary for sports such as basketball, volleyball and baseball, and they also highlight the importance of foot-eye co-ordination, to get into the best position, to perform a hand-eye co-ordination task. Barnhardt *et al.* (2005) found in their study of 37, eight to thirteen year old American children that children who had poor visual-motor integration skills made significantly more errors in skills with a visual perceptual component. Tepeli (2013) furthermore stated that visual perception and motor performance were closely linked to each other. Bonifacci (2004), in his study of 141 Brazilian children, aged six- to 10 years, found a significant difference in visual-motor integration skills between children with low and high gross motor skills.

Visual perception is a complex process involved in both object identification and locating of an object in space (Jeannerod, 2006). This system is also intricately connected to the action systems of the body (Jeannerod, 2006), and relies on the candor of the posterior parietal cortex and cortical networks produced from the occipital lobe (Lieberman, 1984; Ganis *et al.*, 2004). Defects in treatment of the visual signals at different points can lead to problems in movement planning, movement correction and feedback control (Wilson & McKenzie, 1998; Winnick, 2011). Visual perception comprises of more than one concept which includes object/form perception and spatial perception. Object/Form perception can

further be broken down into form consistency, visual closure and figure-ground perception (Scheck, 2010). These concepts are all relevant in a situation where object control skills are used. Form consistency is the ability to recognize objects in different environments, sizes and positions, figure-ground perception includes being able to define objects from the foreground or background, visual closure is the ability to recognize a shape or form when incomplete and spatial perception, the ability to locate an object in space, (Schneck, 2010). These perceptual abilities will enable learners to locate a ball in space for instance, and be able to accurately catch or throw it back to a teammate in a sporting position. According to Wilson and Falkel (2004) visual perception in sport involves an athlete being able to focus on the ball, whilst keeping the different positions of his teammates and the position of the opposition in addition, researchers (Smith *et al.*, 2003; Cinelli, 2006; Gabbard, 2008) claim that visual perception is the ability to perceive if an environment is safe enough, which then leads to perception, which is necessary to discern actions. Wilson and McKenzie (1998) found that problems with visual components were associated with problems in motor co-ordination. A study by Tepeli (2013), on 322 Turkish children ranging from 54 to 59 months, found that these children's visual perception skills improved as their gross motor skills (locomotor- and object control skills) improved and vice versa. This researcher also found that visual perception could be a predictor of good execution of object control skills (Tepeli, 2013).

Motor co-ordination describes the process of obtaining visual information and responding with the correct co-ordination of the mind and body (Maneval, 1999), while Cheatum and Hammond (2000) refer to motor co-ordination as the ability to co-ordinate body movement and vision. Visual-motor skills are inadmissible to success in school and social life (Maneval, 1999) and plays a crucial role in activities where hand-eye and foot-eye co-ordination is important, especially in sports such as rugby, hockey, netball and soccer, where a ball has to be kicked, hit or caught, while paying attention to an opponent (Cheatum & Hammond, 2000). Wilson and Falkel (2004) indicated that visual-motor integration is one of the most basic components to be linked to sport performance. These researchers (Wilson & Falkel, 2004) also indicated that if the eyes are unable to move quickly and efficiently, a child will not be able to perform well in sports. They also stressed the importance of the integration of visual perception and motor co-ordination to be able to perform unforeseen movements on the sport field (Wilson & Falkel, 2004).

Coetzee and Du Plessis (2013) in their study of 816 children (419 boys and 397 girls) in

the North West Province of South Africa, found significant correlations between visual-motor integration and visual perception, and visual-motor integration and motor co-ordination. These researchers also found significant correlations between visual perception and motor co-ordination (Coetzee & Du Plessis, 2013). A conclusion therefore can be made that due to the interrelationship of these skills, any problems that could arise in one of these skills could also affect the others adversely. Sortor and Kulp (2003) reported in this regard that problems with visual-motor integration could be affected by problems in visual perception and/or motor skills.

Manipulation skills, or object control skills as referred to in this study, include those skills that apply force or receive force such as when throwing, catching, striking, dribbling and kicking a ball (Gallahue & Cleland-Donnelly, 2003). Jeannerod (1996) and Winnick (2011) found that locating an object in space was dependent of more complex visual skills such as figure-ground perception, the perception of distance and form constancy. According to researchers (Cheatum & Hammond, 2000; Pienaar, 2014; Willoughby & Polatajko, 1995) the development and/or improvement of motor skills that involve co-ordination (hand-eye and foot-eye) are dependent on visual systems functioning effectively and on good eye muscle control. Deficits in visual perception will contribute to the inaccurate locating of an object, which will affect goal-directed movement negatively. Generally movements could become less skillful due to inadequate visual information (Jeannerod, 1988). However, Bonifacci (2004) indicates that poor performance in motor skills is not necessarily associated with problems in visual perceptual abilities. Tsai *et al.* (2008) supports this finding by claiming that visual perception shortcomings and motor tasks may be task-specific and do not necessarily have an interrelationship.

From the literature it seems that visual-motor integration, visual perception and motor co-ordination may play an important role in object control skills, sporting activities and everyday life. If problems arise in any of these three areas it could have a debilitating effect on sport and life skills.

Little research has been done on the effect that poor visual-motor integration, visual perception and motor co-ordination abilities could have on object control skills. Investigating these relationships will shed light on the potential role that these skills could have on the sport performance of children, and may contribute to a better understanding among teachers in order to improve these skills in the different areas in South Africa.

4.2 METHODOLOGY

4.1.1 Research design

This study is based on a longitudinal study design, Child-Health-Integrated-Learning and Development study (NW-CHILD study), which spans over a period of six years (2010-2016) and include three sequential measurements throughout. Only the baseline (2010) measurements of this project were used for this particular study. Therefore this study was a one-time cross-sectional design.

4.1.2 Participants

This research formed part of the NW-CHILD study. The target population for this study was Grade 1-learners in the North West Province of South Africa. The total number of participants identified for the study was 880 Grade 1-learners. The research group was selected by means of a stratified random sample in conjunction with the Statistical Consultation Services of the North- West University. To determine the research group, a list of names of schools in the North West Province was obtained from the Basic Educational Department of the North West Province. This list of schools was grouped in 4 educational districts, each representing 12 – 22 regions with approximately 20 schools (minimum 12, maximum 47) per region. Regions and schools were randomly selected with regards to population density and school status (Quintile 1, i.e. schools from poor economic sectors, to Quintile 5, i.e. schools from well-off economic sectors). Boys and girls in Grade 1 were then randomly selected from each school. A total of 20 schools were involved in the study, from 4 districts with a minimum of 40 children per school and with an even gender distribution. The total group consisted of 806 learners (413 boys and 393 girls) with a mean age of 6.78 years. During the complete study thirteen parents (1.5%) did not consent to participation, whereas 35 (4.0%) of the selected participants were absent at school on the day of testing or had to be excluded because of incorrect ages that were provide by the schools. The principals of the various identified schools were asked for permission to collect the data during school hours. If the numbers of learners in the school allowed it, 60 Grade 1 learners were randomly selected and received informed consent forms that had to be completed by their parents. This was done to ensure that informed consent would be granted by the parents for a minimum of 40 learners who needed to be tested at each school, so that the power/impact of the study would be sufficient. The learners, whose parents consented, underwent the tests.

4.1.3 Ethical considerations

Ethical approval was obtained from the Ethics Committee of the North-West University, Potchefstroom Campus (No. NWU-0070-09-A1), as well as the Department of Basic Education of the North-West Province. A formal meeting was organized with each principal. The aim and protocol of the study were explained to them, and permission was asked to collect the data during school hours. Trained interpreters were used to convey the instructions of the evaluators to the subjects, if English was not their first language.

4.1.4 Measuring instruments

4.1.4.1 Developmental Test of Visual-Motor Integration – 4th edition – Test battery (VMI-4)

The VMI-4 (Beery & Buktenica, 1997) consists of the visual-motor integration test and two subtests which include visual perception and motor co-ordination. The aim of the VMI-4 is to identify children who need special assistance, by means of early detection. The complete 27-item-VMI test can be administered individually or in groups, it takes about 10-15 minutes to complete, and can be used from pre- school children to adults. The visual-motor integration subtest consists of a list of consecutive geometrical shapes which have to be drawn with a pencil on paper. This test allows 10-15 minutes to be completed or is stopped after 3 consecutive mistakes. The visual perception subtest requires matching shapes with each other and takes 3 minutes to complete or until 3 consecutive mistakes are made. The last subtest, motor co-ordination, involves completing dots in a shape and takes 5 minutes to complete. The criteria for awarding marks in the VMI-4 are as follows: a “0” is awarded for figures that are wrong and a “1” is awarded for the correct figures. The data is captured under the three categories: visual-motor integration, visual perception and motor co- ordination. The raw score is converted to a standard score, and then to a percentile. Using the standard score, children can be grouped into five different classes, ranging from very high (133- 160), high (118-132), average (83-117), low (68-82) to very low (40-67). The VMI-4 was developed to measure the extent to which an individual can integrate his visual and motor capabilities. The VMI-4 subtests have a validity of 0.92, 0.91 and 0.89 respectively (Beery & Buktenica, 1997).

4.2.4.2 Test of Gross-Motor Development - 2 – Test battery (TGMD-2)

The TGMD-2 test is designed to test the gross motor functioning of children from three to ten years old (Ulrich, 2000). This test consists of 12 motor skills, and is divided into two

subtests, namely locomotor (run, hop, gallop, leap, horizontal jump and slide) and object control (striking a stationary ball, stationary dribble, catch, kick, overhand throw and underhand roll) skills. For the purpose of this study, only the object control subtest were used. Each of these fundamental motor skills has 3 to 5 performance criteria. For example, there are 5 performance criteria for striking a stationary ball: 1) “Dominant hand grips bat above non-dominant hand”; 2) “Non-preferred side of the body faces the imaginary tossed ball with feet parallel”; 3) “Hip and shoulder rotation during swing”; 4) “Transfers body weight to front foot”; and 5) “Bat contacts ball”. Marks will be allocated as follow: 1 point will be awarded for each correct execution of the specific skills and 0 for a failed attempt. The child will get two attempts at each skill. A visual demonstration of each skill before it is tested, but the component that is assessed for every skill is not allowed to be told. The score for each of the 2 attempts for each performance criteria must be added together. To get the skill score, all the total scores for each criterion must be added together. At the end of the object control subtest, the 6 skill scores must be added up to determine the subtest raw score of 48 points. The child’s age, gender and raw score are used to calculate the standard score and percentile rank. The descriptive categories of the TGMD-2’s manual are: excellent (subtest standard score 17-20), good (15-16), above average (13-14), average (8-12), below average (6-7), poor (4-5) and very poor (1-3). A standard score between 1- 3 is therefore considered to be very low mastery of the object control skill, while a score of 17- 20 is considered very good mastery of the object control skill. The TGMD-2 has proven that it is reliable in three areas, namely Content-Description validity, Criterion-Prediction validity and Construct-Identification validity. The test has been found to be reliable in all demographic subgroups with quotients reaching or exceeding 0.87 (Ulrich, 2000).

4.1.5 Statistical analysis

Data analysis was done with the STATISTICA software package (StatSoft, 2013). Firstly, descriptive statistics, (mean (M), standard deviations (SD), minimum and maximum values) of each variable was calculated. Secondly, Spearman rank order correlation was used to determine the correlations among visual-motor integration, visual perception, motor coordination, striking a stationary ball, stationary dribble, catching, kicking, underhand rolling, overhand throwing and the object control skills total. The strength of the correlation is set at $r \approx 0.1$ indicating a small effect, $r \approx 0.3$ indicating a medium effect and $r \approx 0.5$ a large effect (Cohen, 1988). Lastly ANOVA was used to determine the relationship between visual-motor integration, visual perception, motor co-ordination and

object control skills. Statistical significance was set at $p \leq 0.05$.

4.3 RESULTS

A total of 413 boys and 393 girls were identified as participants for this study. The group had a mean age of 6.84 years ($SD = 0.39$) with the boys having a slightly higher mean age of 6.87 years ($SD = 0.39$) compared to the girls (6.81 years, $SD = 0.38$). Table 1 display the composition of the study population by gender and age.

TABLE 4.1: GROUP CHARACTERISTICS BY GENDER AND AGE

Study population	N	M	SD	Minimum	Maximum
Boys	413	6.87	0.39	6.00	7.67
Girls	393	6.81	0.38	6.00	7.67
Total	806	6.84	0.39	6.00	7.67

N= number of participants; M=mean; SD=standard deviation

Table 4.2 displays the results of the mean scores obtained in each test variable for the 806 participants. The mean scores vary from high to low in the various object control skills, where the participants obtained the highest mean score in striking a stationary ball (6.78 ± 1.84). The participants also received high mean scores in visual-motor integration (91.46 ± 13.78), motor co-ordination (92.88 ± 14.72) and a slightly lower mean score in visual perception (79.12 ± 22.96).

Table 4.3 a Spearman rank order correlation was used to determine the correlations among visual-motor integration, visual perception, motor co-ordination and the six object control skills which include striking a stationary ball, stationary dribble, catch, kick, underhand roll and overhand throw. The results in Table 4.3 indicate small significant correlations ($r \geq 0.1$) between visual-motor integration and four (stationary dribble, catching, overhand throwing, underhand rolling) of the object control skills, including the object control total.

TABLE 4.2: VISUAL-MOTOR INTEGRATION, VISUAL PERCEPTION, MOTOR CO-ORDINATION AND OBJECT CONTROL SKILLS OF THE GROUP

Variables	M (N=806)	SD	Min	Max
Object control skills				
Striking a stationary ball	6.78	1.84	0.00	10.00
Stationary dribble	4.17	2.42	0.00	8.00
Catch	4.70	1.12	2.00	8.00
Kick	6.07	1.42	1.00	8.00
Overhand throwing	2.88	2.34	0.00	8.00
Underhand rolling	4.36	1.87	0.00	8.00
Object control skills total	7.10	2.16	1.00	14.00
VMI-4				
Visual-motor integration	91.46	13.78	0.00	155.00
Visual perception	79.12	22.96	0.00	139.00
Motor co-ordination	92.88	14.72	0.00	140.00

N=number of participants; m=mean; min=minimum; max=maximum; SD=standard deviation; VMI- 4=Visual-Motor Integration 4th ed.

Visual perception also showed a small correlation ($r \geq 0.1$) with all six (striking a stationary ball, stationary dribble, catching, kicking, overhand throwing, underhand rolling) of the object control skills, while a correlation with a medium effect ($r=0.3$) was found between visual perception and the object control skills total (see Tabel 4.3). Motor co-ordination only shows small significant ($r \geq 0.1$) correlations with two (stationary dribble, underhand rolling and the object control total) of the object control skills as well as the object control skill total, while no correlations were found between striking a stationary ball, catching, kicking, and overhand throw ($r \leq 0.1$).

TABLE 4.3: CORRELATION BETWEEN VISUAL-MOTOR INTEGRATION, VISUAL PERCEPTION, MOTOR COORDINATION AND OBJECT CONTROL SKILLS

Variable	VMI SS	VP SS	MC SS
Striking a stationary ball	0.06	0.12*	0.07
Stationary dribble	0.14*	0.14*	0.14*
Catch	0.11*	0.16*	0.06
Kick	-0.06	-0.12*	0.02
Overhand throw	0.09*	0.14*	0.00
Underhand rolling	0.17*	0.19*	0.09*
Object control skills total	0.21*	0.27[#]	0.18*

*VMI=Visual-motor integration; VP=Visual perception; MC=Motor coordination; SS=Standard Score; Significance accepted: $r \geq 0.1$ *=small, $r \geq 0.3$ [#]=medium*

In Table 4.4 an ANOVA were used to analyse the relationship between values obtained and classified into different visual-motor integration-, visual perception- and motor co-ordination classes with the different object control skills. The visual-motor integration as seen in Table 4.4 classes were grouped into five different classes, ranging from very high (133-160, Class 1), high (118-132, Class 2), average (83-117, Class 3), low (68-82, Class 4) to very low (40-67, Class 5). For the purposes of this study the children in class one and two were combined due to the small number of children who were classified in Class 1. Table 4.4 further indicates that there was a statistically significant association ($p \leq 0.01$) between visual-motor integration and stationary dribble, underhand rolling and the object control skills total. In stationary dribble, a tendency of a decline of the visual-motor integration mean scores was seen from Class 2 to Class 5. From the results it seems that as the visual-motor integration values decreased so did the stationary dribble values. The same tendency was found in the underhand rolling and the object control total scores. In all both these skills and object control skills total there was statistically significant association ($p \leq 0.05$) between Class 2 through to Class 5.

Table 4.4 further indicated that visual perception had a statistically significant association ($p \leq 0.05$) with striking a stationary ball, stationary dribble, catch, overhand throw, underhand rolling and object control skills total. A tendency of higher mean scores for visual perception was found for the participants that were classified in Class 2 (High), with a linear decline to Class 5 (Very low), that could be observed in striking a stationary ball, catch, overhand throw and the object control skills total. Only the mean scores for underhand rolling and stationary dribble had a slight incline from Class 2 to Class 3.

In motor co-ordination, underhand rolling and the object control skills total scores showed a consistent decline from Class 2 to Class 5. Stationary dribble had a slight increase from Class 2 to 3 and then continued declining from there on out. There was a statistically significant association ($p \leq 0.05$) between the classes in these three skills: visual-motor integration, visual perception and motor co-ordination.

TABLE 4.4: INTERACTION BETWEEN VISUAL-MOTOR INTEGRATION, VISUAL PERCEPTION, MOTOR COORDINATION CLASSES AND OBJECT CONTROL SKILLS

Variables	Class 2	Class 3	Class 4	Class 5	MSE	p
Visual-motor integration						
Striking a stationary ball	6.64	6.87	6.62	6.14	3.38	0.082
Stationary dribble	4.52	4.36 ⁽⁴⁾	3.54	3.43	5.75	≤0.001*
Catch	5.04	4.73	4.50	4.74	1.24	0.060
Kick	5.76	6.09	6.12	5.83	2.02	0.475
Overhand throw	3.12	2.95	2.68	2.34	5.45	0.291
Underhand rolling	5.36 ⁽⁵⁾	4.44	4.09	3.49	3.42	≤0.001
Object control skills total	7.92 ⁽⁵⁾	7.23 ⁽⁴⁾	6.45	6.23	4.52	≤0.001
Visual perception						
Striking a stationary ball	7.05	7.02 ⁽⁵⁾	6.78	6.41	3.34	≤0.001
Stationary dribble	4.47	4.57 ⁽⁴⁻⁵⁾	4.00	3.80	5.77	≤0.001
Catch	5.05	4.84 ⁽⁵⁾	4.65	4.50	1.23	≤0.001
Kick	5.66	5.96	6.16	6.19	2.01	0.057
Overhand throw	3.89 ⁽⁵⁾	3.17 ⁽⁵⁾	2.74	2.49	5.34	≤0.001
Underhand rolling	4.74	4.78 ⁽⁴⁻⁵⁾	4.25	3.88	3.37	≤0.001
Object control skills total	8.11 ⁽⁵⁾	7.57 ⁽⁴⁻⁵⁾	6.99 ⁽⁵⁾	6.29	4.36	≤0.001
Motor co-ordination						
Striking a stationary ball	6.73	6.83	6.63	6.43	3.39	0.434
Stationary dribble	3.60	4.33 ⁽⁴⁾	3.47	3.57	5.77	≤0.001
Catch	4.67	4.70	4.78	4.43	1.25	0.381
Kick	5.40	6.13	5.99	5.69	2.01	0.052
Overhand throw	3.67	2.84	3.13	2.67	5.45	0.335
Underhand rolling	4.60 ⁽⁴⁻⁵⁾	4.45 ⁽⁴⁻⁵⁾	4.07	3.74	3.47	0.033*
Object control skills total	7.33 ⁽⁴⁻⁵⁾	7.19 ⁽⁴⁻⁵⁾	6.63	6.17	4.59	≤0.003

*Class 2 = high; Class 3 = average; Class 4 = low; Class 5 = very low; *For statistical purposes, scores of learners in class 1(very high) and 2 (high) were combined due to the small sample size of both the classes; $p \leq 0.05$; M=mean; MSE=mean square error; Upper script indicates a statistical difference between classes.*

4.4 DISCUSSION

The aim of this study was to determine the interrelationship between visual-motor integration, visual perception, motor co-ordination and object control skills.

The results indicated that there were small to medium correlations between visual-motor integration, visual perception, motor co-ordination and the various object control skills. Visual perception showed the largest relationship with all the object control skills and the object control skills total compared to visual-motor integration and motor co-ordination. Tepeli's (2013) study on 54- to 59 months old children in Konya, investigated the

relationship between gross motor skills and visual perception. The findings of Tepeli's (2013) study is in agreement with our findings as this researcher indicates that visual perception is a strong predictor of object control skills.

When the possible interaction between visual-motor integration, visual perception and motor co-ordination with the different object control skills was investigated, visual perception again indicated the most significant effect ($p \leq 0.05$) in five of the six object control skills. These findings are supported by the findings of Wilson and Mackenzie (1998) that showed that children who experience problems with visual perception would have problems in motor tasks. Oktay and Unutkan (2003) also support this finding by stating that visual perception is crucial for tasks such as throwing and grasping. The positive relationship that was found between visual perception and successfully performed object control skills make sense, based on the assumption that a motor action can only be carried out by perceiving sensory information, correctly and to react accordingly. The task is thus accomplished by using body and brain together. As previously mentioned visual perception includes form consistency, visual closure and figure-ground perception (Scheck, 2010). Form consistency is necessary to recognize an approaching ball, whichever size or position, figure-ground perception enables the child in any given sport situation to be able to focus on an oncoming ball or teammate. Visual closure and spatial perception, is needed so that a child can accurately track a ball in sport, thrown by a teammate or to position himself to be available for the opportunity to catch a ball (Schneck, 2010).

Kicking was the only skill which had a negative interaction with visual perception although the relationship was not significant. According to Bonifacci (2004) in his study on 144 children (six- to 10 years) poor performance in motor skills was not necessarily associated with poor visual perceptual skills. Tsai *et al.* (2008) also found motor tasks and visual perception to be specific and not to necessarily have a relationship. Other studies that made similar comparisons are however limited to compare our findings with.

Visual-motor integration only had significant correlations with four of the six object control skills as well as the object control skills total. When looking at the possible interaction between visual-motor integration and object control skills only stationary dribble, underhand rolling and the object control skills total were significantly better in Class 2 (high) and 3 (average) compared to Class 4 (low) and 5 (very low). Wilson and Falkel (2004) support this finding by stating that visual-motor integration is one of the components that can

easily be linked to performance in sport, they furthermore state that good co-ordination between the hands and eyes are important for sports such as basketball, volleyball and baseball. Bonifacci (2004) in his study of 141 Brazilian children, aged six- to 10 years, found a significant difference in visual-motor integration skills between children with low and high gross motor skills.

Motor co-ordination correlated with two of the six object control skills and when the possible interaction was studied, motor co-ordination only had significant relationships with stationary dribble, underhand rolling and the object control skills total, where children had higher mean scores in Class 2 (high) and 3 (average) compared to Class 4 (low) and 5 (very low). Motor co-ordination showed a very small correlation with object control skills in this study. This is in contrast with previous research which found that motor co-ordination is crucial in activities where hand-eye and foot-eye co-ordination is important (Cheatum & Hammond, 2000). Possible reasons for this could be that the motor co-ordination task in this study relies on hand control and more on fine motor skills in comparison to the object control skills which rely on the use of gross motor skills during this study.

4.5 CONCLUSION

While conducting this research it has become clear that this study is the first of its kind, investigating the interrelationship between the VMI-4 and TGMD-2. Due to the possible various effects that visual skills may have on sport skills, it seemed important to investigate the effect that these skills might have on basic ball skills, which could later have an effect on sport skills. It was further difficult to find literature with specific regards to a normal South African population, to support or disprove our findings. A possible reason for this could be the fact that the VMI-4 test battery was not originally designed to be compared to gross motor skills, but rather with test batteries focusing on visual skills and fine motor skills. However, there were small correlations between components that required hand control such as dribbling, rolling and striking a stationary ball and motor co-ordination, but there were little to none with components which did not require it such as kicking and catching. This article did however provide important information with regards to visual-motor integration, visual perception, motor co-ordination and object control skills.

The results of this study indicate that there were limited interaction between visual-motor integration, motor co-ordination and object control skills. However, there were various relationships between visual perception and object control skills.

4.6 LIMITATIONS AND RECOMMENDATIONS

Although this study provided meaningful information, it did however, have limitations that need to be acknowledged, which could be overcome with further research. Differences between genders were not recorded in this study and could have influenced relationships and it is recommended that future research incorporates this when studying the interaction between visual-motor integration, visual perception, motor co-ordination and object control skills due to boys and girls motor skills varying. Socio-economic status was also not taken into account and the test battery used for the visual skills, might not have been the most appropriate choice to the object control skills.

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Disclaimer: Any opinion, findings and conclusions or recommendations expressed in this material are the opinion of the author(s) and therefore the MRC and/or NRF do not accept any liability in regard there to.

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CHAPTER 5



Chapter 5

Summary, Conclusion, Limitations and

Recommendations Table of Contents

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5.1 Summary

The dissertation had two main objectives. The first objective was to determine the effect of gender and school types associated with different socio-economic conditions on the visual-motor integration, visual perception and motor co-ordination abilities of Grade 1 boys and girls in the North West Province of South Africa, and secondly to determine the relationship between visual- motor integration, visual perception, motor co-ordination and object control skills of Grade 1- learners in the North West Province. The problem statement, objectives and hypotheses are discussed in more detail in Chapter 1.

Chapter 2 includes a literature review related to the aims of this study and firstly describes the visual system, terminology describing visual-motor integration, visual perception and motor co- ordination. Secondly, the anatomy of the visual systems is described, after which the sensory systems involved in vision, the occurrence, symptoms and consequences of visual problems and the possible effect of gender and socio-economic status (SES) on the three main visual skills (namely visual-motor integration, visual perception and motor coordination), were discussed. Thirdly, literature regarding object control skills was investigated with regards to relevant terminology, consequences, both academic and sport-related, due to movement problems. Fourthly the effect of gender and socio-economic status on

object control skills and the influence of visual-motor integration, visual perception and motor co-ordination skills on object control skills were discussed. The literature review indicated that the visual system plays an important role with regards to gross- and fine motor, sport- and academic abilities, specifically abilities such as visual perception. Furthermore, this literature review highlighted certain visual skills, such as visual- motor integration, visual perception and motor co-ordination with regards to their influence on object control skills. The literature review also substantiated that problems in visual skills could lead to problems in academic and sport skills. The review indicated that visual-motor integration was important for fine-motor skills such as writing, typing on a keyboard and gross motor skills, such as throwing or catching a ball, while problems with visual perception on the other hand, could lead to learning disabilities later in a child's life. The literature review also indicated that motor co-ordination played an important role in hand-eye co-ordination, and if problems should occur with this skill, it could lead to problems with sport skills and academic achievements. The effect of gender in visual-motor integration, visual perception and motor co-ordination is still controversial, although literature is clearer about the effect that socio-economic status has on these abilities. From the literature it does seem that children who live in lower socio-economic circumstances tend to have more delays in comparison to children in higher socio-economic status, with regard to visual-motor integration, visual perception and motor co-ordination, which could lead to poor results in academic achievements.

With regards to object control skills, the literature indicated that fundamental skills had to develop in order to become more sport specific. The literature review also indicated the importance of fundamental skills, which include object control skills in order to develop higher-level skills adequately (any skills used in a sport situation). The review further indicated that fundamental skills form the foundation for all other physical activity and exceptional sport performance relied on visual information. With regards to gender, the literature indicated controversial findings regarding gender differences in object control skills. Socio-economic status however seemed to play a significant role. Children who lived in low socio-economic status communities generally showed poorer fundamental motor skills, which could lead to developmental delays. However, no studies were found that discussed or analysed the relationship between visual- motor integration, visual perception, motor co-ordination and object control skills.

Chapter 3 was prepared in article format and will be submitted to the “*Human movement science journal*”. The article presents the results with regards to the influence of gender and socio-economic status on visual-motor integration, visual perception and motor co-ordination in Grade 1-learners in the North West Province of South Africa. Eight hundred and sixteen Grade 1-learners (419 boys and 397 girls) from Quintile 1 - Quintile 5 schools (1 = low socio-economic and 5 = high socio-economic) were tested, with a mean age of 6.78 years (SD=0.49). The Developmental Test of Visual-Motor Integration 4th ed. (VMI-4) was used to evaluate visual- motor integration, visual perception and motor co-ordination skills. Data analysis was done with the STATISTICA software package (StatSoft, 2013). Firstly, descriptive statistics (mean (M), standard deviations (SD), minimum and maximum values) of each variable was calculated. ANOVA was used to determine the interaction effect between gender/socio-economic status and visual-motor integration, visual perception and motor co-ordination. An independent t-test was used to determine the effect of gender differences and socio-economic status in visual-motor integration, visual perception and motor co-ordination. Effect size (d) was used to calculate practical significance. Two-way frequency tables were used to compare the classifications of the different school quintiles among the VMI-4-classes. The Pearson Chi-square was used to indicate the significance of the differences and the level of statistical significance was set at $p \leq 0.05$. The results indicated that gender had no significant effect on visual-motor integration, visual perception and motor co-ordination within the respective school types. Socio-economic status however had a significant effect ($p=0.001$) on visual-motor integration, visual perception and motor co-ordination in boys and girls respectively. It can be concluded that visual-motor integration, visual perception and motor co-ordination are not influenced by differences by gender in different SES school types, but that lower socio-economic status has a negative effect on the visual-motor integration, visual perception and motor co-ordination skills of children.

Chapter 4 was also presented in article format and will be submitted to the “*South African journal for research in sport, physical education and recreation*”. The article presents the results obtained with regards to the interrelationships between visual-motor integration, visual perception, motor co-ordination and object control skills of Grade 1-learners in the North West Province of South Africa. A total of 806 Grade 1 learners (413 boys and 393 girls) from Quintile 1 to Quintile 5 (1 = low socio-economic and 5 = high socio-economic) schools took part in this study, with a mean age of 6.84 years

(SD=0.39). The Developmental Test of Visual-Motor Integration 4th ed. (VMI-4) was used to evaluate visual-motor integration, visual perception and motor co-ordination skills and the Test of Gross Motor Development-2 (TGMD-2) was used to evaluate the object control skills. Data analysis was done with the STATISTICA software package (StatSoft, 2013). Firstly, descriptive statistics, (mean (M), standard deviations (SD), minimum and maximum values) of each variable was calculated. Secondly, a Spearman rank order correlation was used to determine the correlations between visual-motor integration, visual perception, motor co-ordination, and 6 object control skills, namely striking a stationary ball, stationary dribble, catch, kick, underhand roll, overhand throw and object control skills total. The results indicated small significant correlations ($r \geq 0.1$) between visual-motor integration and four object control skills as well as the object control total. Visual perception also showed small correlations ($r \geq 0.1$) and a statistically significant interaction ($p \leq 0.05$) with all 6 object control skills. Motor co-ordination, which reflected hand control in this study, only showed small significant correlations and only with stationary dribble and underhand rolling and the object control skills total. Data was further analysed according to the visual-motor integration classes, visual perception classes and motor co-ordination classes. With visual-motor integration and stationary dribble, underhand rolling and the object control skills total there was a tendency of a decline of the mean scores from Class 2 to Class 5. From the results it seems as if these participants' visual-motor integration became less skilful so did their stationary dribble, underhand rolling and total of object control skills. Visual perception had tendencies of higher mean scores in Class 2 (High), with a gradual decline of scores to Class 5 (Very low), which can be observed between visual perception and striking a stationary ball, catch, overhand throw and object control skills total. Motor co-ordination and underhand rolling and object control skills total, indicated a steady decline from the mean scores in Class 2 to the mean scores in Class 5. Stationary dribble had a slight increase from Class 2 to 3 and then continued, declining from there on out. It can be concluded that visual perception plays a significant role in object control skills. These results are important to sport coaches and human movement science experts due to the effect that visual skills, especially visual perception, could have on sport performance later in life.

5.2 Conclusions

The conclusions of this dissertation are based on the results of this study.

5.2.1 Conclusion 1

Hypotheses 1 state that boys and girls in school types associated with low socio-economic circumstances will show significantly poorer visual-motor integration, visual perception and motor co-ordination than boys and girls in Grade 1 in school types associated with higher socio-economic status (SES) in the North West Province of South Africa. The results of this study indicate no significant differences between the boys and girls regarding visual-motor integration, visual perception and motor co-ordination, within the respective school types. Poor SES, however, had a significant negative effect ($p=0.001$) on visual-motor integration, visual perception and motor co-ordination within the boys' and girls' respectively. Based on these findings the hypotheses as stated above, is **accepted for socio-economic status but rejected for gender**.

5.2.2 Conclusion 2

Hypotheses 2 indicates that there will be a positive relationship between the visual-motor integration, visual perception, motor co-ordination and object control skills of Grade 1 learners' in the North West Province of South Africa. The results of this study indicated small significant correlations ($r \geq 0.1$) between visual-motor integration and two of the six object control skills as well as the total. Visual perception also showed small correlations ($r \geq 0.1$) with all six of the object control skills, and a correlation with a medium effect ($r \geq 0.3$) with the object control total. Motor co-ordination showed small significant correlations with only two of the object control skills and total. A statistically significant interaction ($p \leq 0.05$) was also found between the different classes in three visual skills and object control skills. The hypotheses based on these findings, is **partially accepted**.

From article one and two we concluded that although gender did not influence visual-motor integration, visual perception and motor co-ordination, socio-economic status did had an influence on the above mentioned skills. Furthermore, visual perception plays a large role, compared to visual-motor integration and motor co-ordination in object control skills. If a child therefore comes from a disadvantaged community and has visual perceptual delays his/her object control skills will be negatively affected.

5.3 Recommendations and Limitations

The results of this dissertation indicated that there were no gender differences regarding visual- motor integration, visual perception and motor co-ordination with regards to

different school types associated with different socio-economic status. It did however indicate that school types associated with poor socio-economic status could have a negative impact on visual-motor integration, visual perception and motor co-ordination. It is therefore recommended that the knowledge generated from this study about the possible relationship between SES and different visual skills, is used to inform or educate Kinderkineticists, occupational therapists and teachers of this possible relationship so that it can be addressed by means of specific workshops and perceptual-motor programs in schools. This recommendation is especially relevant to schools in lower socio-economic areas in order to address these problems.

The results of this dissertation further indicated that the interrelationships between visual-motor integration, motor co-ordination and object control skills were limited although of small practical significance, and that visual perception had a bigger relationship with the six object control skills. It is therefore recommended that perceptual-motor programs, which address visual perceptual shortcomings, be implemented in schools by the Grade 1 teachers, during the physical education periods, in order for object control skills to develop optimally.

Although all efforts were made in this dissertation to generalize the results, there were some limitations which should be brought to light in order to optimize future studies in this regard. The following limitations were:

5.3.1 The results of the study were based on data obtained from only one of the nine provinces in South Africa. Although this study was based on a randomized study design, and has relative good generalizability, it is recommended that future studies should be conducted to incorporate all the other eight provinces of South Africa.

5.3.2 This study did not take gender into account when studying the relationships between visual-motor integration, visual perception, motor co-ordination and object control skills. It is recommended that future studies incorporate gender when researching this relationship.

5.3.3 Motor coordination had the weakest relationship with object control skills. A possible reason for this could be that the VMI-4 is mainly developed for the assessment of visual and fine-motor skills. It is recommended that future similar

studies make use of a more specific form of visual testing when comparing visual-motor integration, visual perception and motor co-ordination to object control or sporting skills.

5.3.4 In this study socio-economic status was only based on the respective school types. Future studies should perhaps look at SES in more depth, by making use of information obtained by demographic questionnaires.

5.3.5 As this study indicated that perceptual motor problems can be the result of visual motor integration and visual perception difficulties, especially in schools associated with poor SES, it is recommended that further research should be done where perceptual motor development programs are designed and the effects of such programs are tested among grade 1 learners.

APPENDIX A



RESEARCH PROJECT – A profile and strategies for improvement of body composition, perceptual-motor, physical and visual abilities of 7-year-old children living in the North-West province of South Africa.

This research project is approved by the Department of Basic Education and the Ethics committee of the North-West University, Potchefstroom Campus. The headmaster of your school has also agreed that we may continue with the project.

Your child is part of a group that were selected to participate in the following research project.

The aim of this research project is:

- To gain information about 7-year-old children's body composition, perceptual-motor, physical and visual abilities and blood pressure and to develop from these strategies to improve health promoting problems and other backlogs that can hamper the quality of life and further development of children in this age group. The physical assessments will be done by qualified researchers, is safe for the children to participate in, is age specific and requires minimal effort of the child. Two skinfolds will be taken (one on the arm and one on the calf).

By allowing your child to take part in this research project, it will not only be beneficial for him/her, but will also provide information for parents, teachers and other specialists that they can use to optimize the development of children in this age group. We therefore would like to ask you to consider it strongly to allow your child to participate in the project. You are, however, entitled to withdraw your child at any time from the study, without any explanation. All testing will be completed in one day and feedback will be given to teachers and schools after the data is processed. For further information about this project, feel free to contact any of the persons indicated below.

Prof. A.E. Pienaar
Project Leader

Mrs. Chanelle Kemp
Kinderkineticist, Researcher

(School for Biokinetics, Recreation and Sport Science)

(018) 299 1796 (w)

082 331 1494 / (018) 299 1797 (w)



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Please send this form back to school the NEXT DAY.

_____ ✂ _____ ✂ _____ ✂ _____

I, as the parent understand that I am under no obligation to let my child participate in this research project. I understand that my child would not be harmed in any way, physically or spiritually. I understand that there would be no costs involved in the evaluation and that the research will not interfere with my child's school work.

Hereby I _____ parent/ legal caregiver of
 _____ (full name of child)
 _____ (Date of birth) give permission that he/she may participate in the research project.

 Signature

 Date



NAVORSINGSPROJEK – 'n Profiel en strategieë ter verbetering van liggaamsamestelling, perseptueel-motoriese, fisieke en visuele vermoëns van 7-jarige kinders woonagtig in die Noordwes provinsie van Suid-Afrika.

Hierdie navorsingsprojek is goedgekeur deur die Onderwysdepartement sowel as die Etiese komitee van die Noordwes-Universiteit, Potchefstroomkampus. Toestemming is ook by u skoolhoof verkry om voort te gaan met die navorsing.

U kind is deel van die groep wat geselekteer is om aan bogenoemde navorsingsprojek deel te neem.

Die doel van hierdie navorsingsprojek is:

- Om inligting te versamel oor 7-jarige kinders se liggaamsamestelling, perseptueel-motoriese, fisieke en visuele vermoëns en bloeddruk en hieruit strategieë te ontwikkel ter verbetering van gesondheidsbevorderende - sowel as ander agterstande wat kinders se lewenskwaliteit en verdere ontwikkeling kan belemmer. Die fisieke toetse sal deur gekwalifiseerde navorsers uitgevoer word, is veilig om aan deel te neem, ouderdomsgepas en verg min inspanning van die kind. Twee velvoue sal geneem word (een op die arm en een op die kuit).

Deur u kind aan die bogenoemde navorsingsprojek te laat deelneem, kan dit nie net vir u kind tot voordeel wees nie, maar ook vir ouers, onderwysers en kundiges, inligting verleen wat gebruik kan word om kinders van hierdie ouderdom se ontwikkeling te optimaliseer. Ons vra dus dat u dit sterk sal oorweeg om hom/haar te laat deelneem aan die navorsing. U is uiteraard geregtig om u kind op enige stadium, sonder enige verduideliking, te onttrek van die studie. Terugvoering sal aan die betrokke kinders se onderwysers en skole gegee word nadat alle toetsings wat op een dag sal geskied, afgehandel en die inligting verwerk is. Vir enige verdere inligting oor die projek, kan enige van die onderstaande persone gekontak word.

Prof. A.E. Pienaar

Projekleier

(Skool vir Biokinetika, Rekreasie en Sportwetenskap)

(018) 299 1796 (w)

082 331 1494 / (018) 299 1797 (w)

Mev. Chanelle Kemp

Kinderkinetikus, Navorser

Stuur asseblief hierdie vorm die VOLGENDE DAG terug skool toe, hetsy dit ingevul is al dan nie.

_____ ✂ _____ ✂ _____ ✂ _____

Ek as ouer verstaan dat ek onder geen verpligting is om my kind aan die navorsingsprojek te laat deelneem nie. Ek verstaan dat daar geen skade aan my kind berokken gaan word, hetsy fisies of geestelik nie. Ek verstaan ook dat daar geen kostes verbonde is aan die evaluering nie en dat dit ook nie sal inmeng met my kind se skoolaktiwiteite nie.

Hiermee gee ek _____ ouer/wettige voog
van _____ (Kind se volle name en van)
_____ (Geboortedatum) toestemming dat hy/sy aan die navorsingsprojek mag
deelneem.

Handtekening

Datum

APPENDIX B

Human Movement Science Journal Author Guidelines

Human Movement Science provides a medium for publishing disciplinary and multidisciplinary studies on human movement. It brings together psychological, biomechanical and neurophysiological research on the control, organization and learning of human movement, including the perceptual support of movement. The overarching goal of the journal is to publish articles that help advance theoretical understanding of the control and organization of human movement, as well as changes therein as a function of development, learning and rehabilitation. The nature of the research reported may vary from fundamental theoretical or empirical studies to more applied studies in the fields of, for example, sport, dance and rehabilitation with the proviso that all studies have a distinct theoretical bearing. Also, reviews and meta-studies advancing the understanding of human movement are welcome.

These aims and scope imply that purely descriptive studies are not acceptable, while methodological articles are only acceptable if the methodology in question opens up new vistas in understanding the control and organization of human movement. The same holds for articles on exercise physiology, which in general are not supported, unless they speak to the control and organization of human movement. In general, it is required that the theoretical message of articles published in Human Movement Science is, to a certain extent, innovative and not dismissible as just "more of the same."

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Contact details

If authors have no facilities to submit their manuscripts electronically, they may send three copies of their manuscript with a diskette to:

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Introduction

State the objectives of the work and provide an adequate background, avoiding a detailed literature survey or a summary of the results.

Results

Results should be clear and concise.

Discussion

This should explore the significance of the results of the work, not repeat them. A combined Results and Discussion section is often appropriate. Avoid extensive citations and discussion of published literature.

Conclusions

The main conclusions of the study may be presented in a short Conclusions section, which may stand alone or form a subsection of a Discussion or Results and Discussion section.

Appendices

If there is more than one appendix, they should be identified as A, B, etc. Formulae and equations in appendices should be given separate numbering: Eq. (A.1), Eq. (A.2), etc.; in a subsequent appendix, Eq. (B.1) and so on. Similarly for tables and figures: Table A.1; Fig. A.1, etc.

Essential title page information

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A concise and factual abstract is required. The abstract should state briefly the purpose of the research, the principal results and major conclusions. An abstract is often presented separately from the article, so it must be able to stand alone. For this reason, References should be avoided, but if essential, then cite the author(s) and year(s). Also, non-standard or uncommon abbreviations should be avoided, but if essential they must be defined at their first mention in the abstract itself.

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Present simple formulae in the line of normal text where possible and use the solidus (/) instead of a horizontal line for small fractional terms, e.g., X/Y. In principle, variables are to be presented in italics. Powers of e are often more conveniently denoted by exp. Number consecutively any equations that have to be displayed separately from the text (if referred to explicitly in the text).

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APPENDIX C

General Content Guidelines for South African Journal for Research in Sport, Physical Education and Recreation

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Authors are also requested to name three (3) potential referees, of which one (1) **must** be an international referee (the journal is not bound to use these referees). Complete information regarding the referees (name, surname, e-mail address and telephone numbers) must be *South African Journal for Research in Sport, Physical Education and Recreation* provided in the cover letter. We discourage the practice of parts of one study in different journals. Authors who submit a manuscript from a study of which some data has been or will be published elsewhere, must provide a strong justification in an accompanying letter to the Editor. The justification for not publishing all the data together in one paper must also be motivated in the covering letter.

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The first page of each manuscript should indicate the *title* in English and Afrikaans (will be translated for foreign authors), the *names* (**title, first name in full and other initials, surname**) of the author(s), the *telephone* numbers (work & home [Mobile – for local authors]), *facsimile* number, *e-mail* address (if available) and the *field of study*. The **complete mailing address** of the first named author and the institution where the work was conducted should be provided in full. When more than one author and/or authors from various departments are involved the **1author(s)** must be numbered according to their **1department(s)**. If any of the above-mentioned information should change during the review process, please inform the subject editor. A **short title**, of not more than **45 characters** including the spaces, should be provided for use as a running head.

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List of references

Only the references cited in the text should be listed alphabetically according to surname (last name) of authors (capitals) after the body of text under the heading, **References** (capitals) starting on a new page. In the case where the TITLE of an article, book, etc., is in any other language than English, the author must also provide an English translation of the title in parentheses.

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CAPE ARGUS (The) (1980). 10 January, p.4.

INTERVIEWS*Example:*

POTGIETER, J.R. (2003). Personal interview with the Chairperson of the Department of Sport Science. 31 January. Stellenbosch: Stellenbosch University.

CORRESPONDENCE*Example:*

POTGIETER, J.J.J. (2003). Personal correspondence of the Director of the Sport Bureau, 5 February. Stellenbosch: Stellenbosch University.

CONGRESS PROCEEDINGS*Example:*

RENSON, R. (Ed.) (1976). *The history, the evolution and diffusion of sport and games in different cultures*. Proceedings of the 4th International HISPA Congress, Leuven, Belgium, 1-5 April 1975. Brussels (Belgium): B.L.O.S.O. *South African Journal for Research in Sport, Physical Education and Recreation*

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When referring to a paper presented in the above-mentioned proceedings, it must be presented as follows:

REES, R. (1976). Organisation of sport in nineteenth century Liverpool. In R. Renson (Ed.), *The history, the evolution and diffusion of sport and games in different cultures* (pp.237-247). Proceedings of the 4th International HISPA Congress, Leuven, Belgium, 1-5 April 1975. Brussels (Belgium): B.L.O.S.O.

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APPENDIX D

Proof of Language Editing

CV Language Editing

Translator & editor



Member: South African Translators' Institute (SATI)

Membership nr 1003172

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Declaration

I, Clarina Vorster (ID: 710924 0034 084), Language Editor and Translator, and member of the South African Translators' Institute (SATI member number 1003172), herewith declare that I did the language editing of the Masters Dissertation of ms Wilmarié du Plessis (student number 20376138), student of the North-West University.

Title of the Dissertation: The relationship between object-control skills, visual-motor integration and gender of Grade 1-learners: The NW-CHILD Study

C Vorster

C Vorster

3 Desember 2014

Date

APPENDIX E

Proof of Submission

>>> "Van Deventer, KJ, Dr <sajrsper@sun.ac.za>" <sajrsper@sun.ac.za> 2015/03/19 08:58 AM >>>

Beste Dané

Baie dankie vir die voorlegging van julle artikel vir moontlike publikasie. Die manuskrip nommer is MS 1114.

Ek sal jou laat weet wie die vakredakteur gaan wees.

Groete

Kallie

From: Dané Coetzee [Dane.Coetzee@nwu.ac.za]

Sent: 18 March 2015 10:32 AM

To: Van Deventer, Kallie, Dr <kjvd@sun.ac.za>

Subject: Voorlegging van artikels vir publikasie

Goeie middag Dr. Kallie

Hoe gaan dit met Dok. Ek hoop Dr. het 'n lekker week sover. Ek wil net begin om baie dankie te sê vir die geleentheid om ons artikels voor te lê vir moontlike publikasie in u joernaal.

Vind asseblief aangeheg die volgende dokumentasie:

- 1) Die Dekbrief
- 2) Een artikel getiteld: **Interrelationships between visual-motor integration, visual perception, motor co-ordination and object control skills of Grade 1-learners: the NW-CHILD study**

Ek hoop Dok vind dit in orde so.

Vriendelike groete uit Potchefstroom uit.