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Establishing norms for kinesthetic coordination tasks in 6-year-olds in the Mangaung, Motheo District

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Submitted in fulfilment of the requirements in respect of the

Master's degree in Human Movement Science

in the Department of Exercise & Sport Science**,** School of Health and Rehabilitation Sciences in the Faculty of Health Sciences at the University of the Free State

Date of final submission: 30 November 2021

Supervisor: Dr Elna de Waal

DECLARATION BY THE STUDENT

I, Carmen Bonafede, hereby declare that this dissertation titled: Establishing norms for kinesthetic coordination tasks in 6-year-olds in the Mangaung, Motheo District.

Submitted in fulfilment of the degree, Magister Artium (MA) Human Movement Science, is my independent work, except where other sources have been acknowledged.

I, Carmen Bonafede, declare that the dissertation, titled: *Establishing norms for kinesthetic coordination tasks in 6-year-olds in the Manguang, Motheo District*, that I herewith submit for the Master's Degree qualification in Human Movement Sciences at the University of the Free State is my independent work, and that I have not previously submitted it for a qualification at another institution of higher education.

Signed (Carmen Bonafede)

Date: 29 November 2021

DECLARATION BY THE SUPERVISOR

I Dr Elna de Waal declare and approve the submission of this dissertation and the included articles as fulfilment for the Master's Degree in Human Movement Sciences at the University of the Free State. I also confirm that this dissertation has not previously, either in part or in its entirety, been submitted to examiners or moderators.

EdeWaal

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ABSTRACT

Background: A well-functioning proprioceptive system and overall kinesthetic coordination is foundational to six-year-old children's movement coordination abilities. The age of six is a crucial time in children's developmental years, and in South Africa this is the age when they enter the formal school setting. Intact proprioception and kinesthetic coordination are therefore essential for the six-year-old South African. Several intrinsic and extrinsic factors such as gender, hand dominance and socio-economic status (SES) can influence the kinesthetic coordination abilities of six-year-old children. Norms for kinesthetic coordination testing is not available and testing is either inaccessible to everyone and/or very costly from this the main aim of the study was formed.

Aims: The first aim of this study is to establish norms for kinesthetic coordination tasks in six-year-old children in the Mangaung, Motheo district and, secondly to establish if kinesthetic coordination differences occur in six-year-olds regarding school quintiles, gender and hand dominance.

Setting: The participant group consisted of N=193 six-year-old children of which 97 were boys and 96 were girls, with an average age of 6.46 years (0.27). Participants forming part of this dissertation's study population were from different quintile schools (one to five) in the Mangaung, Motheo district.

Methods: Five kinesthetic coordination tasks (Angels-in-the-snow, Rhomberg, finger-to-nose, shoulder-level-arm raise and force perception) were identified and used to establish norms. Using these norms associated with the five identified kinesthetic coordination tasks differences in school quintiles, gender and hand dominance were studied. Analysis of the study was largely descriptive of nature and norms were calculated using frequencies and percentages. Differences between school quintiles were calculated using the Cochran-Mantel-Haenszel (correlation) chi-square test, and gender and hand dominance differences were calculated using the nonparametric Wilcoxon Two-sample test. Cohens *d* effect sizes were used to calculate practical significance where applicable.

Results: Norms were successfully established for the five kinesthetic coordination tasks. Angels-in-the-snow norms was set at six to ten successful repetitions, Rhomberg norms at 22 – 30 seconds of balance, norms for finger-to-nose for the left and right hand was set at two to three successful repetitions. Norms for shoulder-level-arm-raise for the preferred arm and both arms were set at two to four successful repetitions and for the non-preferred arm at one to four successful repetitions, and lastly for force perception the norm was seen as being able to correctly identify in which hand the heavier weight was placed. Using these norms, it was evident that children in higher SES schools outperformed children in lower SES schools in most of the tasks, except for the Rhomberg task. No significant gender differences in kinesthetic coordination abilities were observed; however, girls mainly outperform boys, with the exception of the shoulder-level-arm-raise task. No practical significance was seen in the Angels-in-the-Snow and Rhomberg tasks regarding gender and preferred arm, although a practical significance was seen for finger-to-nose regarding the left hand and none for gender. For shoulder-level-arm-raise a small practical effect was seen regarding the right hand and again none for gender. No calculations were done for force perception.

Conclusions and recommendations: Norms for kinesthetic coordination tasks in six-year-old children were successfully established. Kinesthetic coordination abilities are to an extent influenced by school quintile statuses, gender and hand dominance, as differences occurred. It is recommended that Kinderkineticists in practice use the established norms of the five kinesthetic coordination tasks to identify children with possible proprioceptive functioning or kinesthetic coordination backlogs. This can be followed by the implementation of a programme that is specifically tailored to each child's individual kinesthetic coordination backlogs. Future research on a larger sample size, in different provinces of South Africa, and on children of different age ranges is advised. It is also recommended that the reliability and validity of the five task items be established in future research.

Keywords: proprioception, kinesthetic coordination, socio-economic status (SES), gender, hand dominance, bilateral coordination, quintiles, norms

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GLOSSARY

Terms:	Definitions:
Balance:	Defined as the ability to keep the body upright against gravity, also related to postural control (Pollock, Durward & Rowe, 2000:402; Magill & Andersen, 2017:54-55).
Bilateral coordination:	The ability to use both sides of the body in order to perform a movement task (Balakrishnan & Rao, 2007:55).
Body schema:	The sensorimotor representations of the body that makes the body perform an action, proprioception, vision, vestibular all play a role in body schema and how they integrate with each other in order to perform the intended action (de Vignemont, 2010:679).
Childhood:	Childhood extents from birth to adulthood and is divided into three periods: early childhood, middle childhood and later childhood (Malina, Bouchard & Bar-Or, 2004:7).
Coordination:	Refers to the relationship of movements of the limbs, body and head involved in the performance of a skill (Magill & Andersen, 2017:88-89).
Fundamental movement skills:	Develop during early childhood and consist of locomotor skills that involve moving the body through space like walking and running as well as object control skills like

	kicking and catching (Goodway, Robinson & Crowe, 2010:17).
Gross motor skills:	The usage of large muscle groups (e.g., legs) to perform a movement (e.g., running) (Goodway, Ozmun & Gallahue, 2019:15).
Hand dominance:	Different patterns in the brain are needed for social, cognitive and emotional development and hand dominance (preference of left or right hand) is formed from these patterns (Michel, Campbell, Marcinowski, Nelson & Babik, 2016:2).
Kinesthetic coordination testing:	Kinesthetic coordination is directly linked to the proprioceptive system and therefore testing is done to assess how a child responds to proprioceptive signals in order to characterise a child's ability to participate in activities of daily life (Chu, 2017:461).
Kinesthesia:	Also referred to as "muscular sense" was derived from Bastian (1887:4) and relates to proprioception and the action and position of the limbs.
Motor control:	The underlying changes (neural and physical) required in the performance of a task (Goodway *et al.,* 2019:13).
Motor skills:	Tasks or activities that require control and coordination over joints and limbs to achieve a desired goal (Magill & Anderson, 2017:3).
Postural control:	Compromises of maintenance of a specific posture voluntary muscle movements and

	the reaction of the body to external stimulus (Pollock, Durward, Rowe & Paul, 2000:404).
Proprioception:	The sensation and perception of limb, trunk, and head position as well as movements of the body (Magill & Anderson, 2014:115). It provides information about the position of body parts to each other, the position of the body in space as well as the nature of the objects that the body comes into contact with (Haywood & Getchall, 2019:273). Proprioception is referred to as the forgotten "sixth sense" and is the second largest system in the human body. It is needed in order for the brain and the body to function effectively (Tarakci *&* Tarakci*,* 2016:3-4).
Sensory systems:	Information from the environment is gained through different sensory systems (Goodway, Ozmun & Gallahue, 2019:373). The information received about taste, smell, touch, pain, sound and vision is send to the central nervous system (Goodway e*t al.,* 2019:373).
Socio-economic status (SES):	Is seen as a combination of measures of different factors like economic and social that includes educational level, housing (amenities and condition), income and occupation (Galobardes, Shaw, Lawlor, Lynch & Smith, 2006:8).
Spatial awareness:	Referred to as the perception of one's own body in space and the relation of objects towards the body in space (Fernandez-Baizan, Arias & Mendez, 2019:17).

Unilateral coordination:	The usage of only one limb of the body at a time (e.g., only the right arm or only the right leg) (Cheatum & Hammond, 2000:199).
Vestibular system:	This is known as the ears balance organs, the vestibular system regulates balance, spatial awareness and helps with movement actions (Day & Fitzpatrick, 2005:R583).

- References used are listed in the reference list (1.8).

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LIST OF ABBREVIATIONS

AMEDA	Active Movement Extent Discrimination Apparatus
APA	American Psychological Association
BOT	Bruininks Oseretsky Test of Motor Proficiency
BOT-2	Bruininks Oseretsky Test of Motor Proficiency, 2nd Edition
COP	Comprehensive Observations of Proprioception
DoBE	Department of Basic Education
FMS	Fundamental Movement Skills
HSREC	Health Sciences Research Ethics Committee
JPR	Joint Position Reproduction
KAT	The test of kinesthetic sensitivity
MABC	Movement Assessment Battery for Children
MRC	Medical Research Council
SD	Standard Deviation
SES	Socio-economic Status
SoHRS	School of Health and Rehabilitation Sciences
TGMD	Test of Gross Motor Development
TTDPM	Threshold to Detection of Passive Motion
UFS	University of the Free State
USA	United States of America

WESP	World Economic Situation and Prospects
±	Standard Deviation

CHAPTER 1: INTRODUCTION

1.1 Introduction

"Proprioception plays a crucial role in human movement control, which is fundamental for daily activities, exercise and sport" (Han, Waddington, Adams, Anson & Liu, 2016:86). Every action of a child is a result of the transaction between the child and their surroundings (Han et al., 2016:80). Children will act appropriately to the type of information that is received from their senses (Manoel, Felicio, Makida-Dionisio, Do Nascimento Soares, Freitas & Gimenez, 2016:461). The forgotten "sixth sense" is referred to as the proprioceptive system (Tarakci & Taracki, 2016:1). Proprioception is described as the ability to interpret and process information from within our bodies (Boisgontier & Swinnen, 2014:1). Proprioception can also be defined as the conscious and subconscious awareness of joint position, joint movement (kinesthesis) sense, and force and effort (Röijezon, Clark & Treleaven, 2015:368).

Proprioception as a sense is required for the coordination of movements, which is accomplished through neurons that can sense the static and dynamic position of the body in space (Montell, 2019:202). Growing evidence concludes that a component of kinesthetic sense is derived from the motor command that generates motor movement (Proske, 2006:545). Motor skills further play an important role in physical activity participation (Cummins, Piek & Dyck, 2005:437; Stodden, Goodway, Langendorfer, Roberton & Rudisill *et al.,* 2008:298) and are involved in children's social and emotional developmental domains (Cummins *et al.*, 2005:437). Another aspect directly related to proprioception and kinesthetic sense is orientation in space, which is also involved in motor development and motor skill execution and is important for cognitive performance (Jansen & Heil, 2010:66).

1.1.1 Proprioception

Proprioception can be categorized into two types, namely passive and active proprioception (Proske & Gandevia, 2012:1653). Passive proprioception is dependent on inputs from the peripheral nervous system (proprioception in the absence of muscle contraction) (Proske & Gandevia, 2012:1653). Active proprioception is proprioception in the presence of muscle contraction (Proske & Gandevia, 2012:1653). Conscious proprioceptive awareness is used to generate awareness of kinesthesia, while this relates directly to joint position, direction, and movement of joints (Siegel & Sapru, 2011:260). Kinesthesis is commonly referred to as the conscious perception of joint motion, while proprioception is referred to as the unconscious awareness of reflexive signals in the body that help maintain posture and bodily control. Proprioception consequently forms the basis for kinesthesia (Konczak, Corcos, Horak, Poizner & Shapiro *et al.,* 2009:543). The differentiation between proprioception and kinesthesia is however no longer a differentiation that is made in research or seen in practice (Blanche, Bodison, Chang & Reinoso, 2012:691).

Proprioception makes use of the ability to integrate sensory signals that have been derived from mechanoreceptors, to determine the position of the body and movement of the body in space (Han *et al*., 2016:81). Receptors that make this possible are receptors found in the vestibular system inside the inner ear, in the muscles, tendons and joints. More specifically, proprioception is complex and requires input from muscles, tendons, joints and cutaneous fibres consisting of limb movement (kinesthesia) sense and static limb position (joint position sense) (Wingert, Burton, Sinclair, Brunstrom & Damiano, 2009:447). There is said to be two kinds of position sense (Proske, 2015:182). One signals the position of one part of the body relative to another, while the other signals the location of the body or parts of the body in space (Proske, 2015:182). Therefore, it is justifiable to say that position and movement sense can provide kinesthetic information to the body accurately (Proske & Gandevia, 2012:1688).

The vestibular system and the proprioceptive system are interrelated and helps keep the body upright against gravity, therefore offering stability (Chu, 2017:459). The vestibular system is important for determining a gravitational sense, orientation and movement of particularly the head (Chu, 2017:459). The integrated information from the proprioceptive system and the vestibular system helps the body maintain functioning balance (Chu, 2017:459). These interactive systems, making up proprioception and body position sense, are needed to improve motor learning (Wong, Wilson & Gribble, 2011:2519). Proprioception is also essential for optimal motor control (Riemann & Lephart, 2002:83). Children with lower motor control skills have low health related fitness levels - this reciprocates the statement that sufficient motor control is needed (Denysschen, Coetzee & Smits-Engelsman, 2021:11).

1.1.2 Motor coordination and proprioception in children

According to Han *et al.* (2016:86) proprioception is an important role player in movement control, which forms the foundation for daily activities, exercise, and sports. Jiang, Jiao, Wu, Ji, Liu, Chen and Wang (2018:350) also recently stated that proprioception and balance are foundational to motor learning and gross motor development, this is especially important during the early childhood years. Motor coordination as a general term used in a study done by Lopes, Stodden, Bianchi, Maia and Rodrigues (2011:2), describes that the term motor coordination encompasses aspects related to motor competency and the ability to perform coordinated motor movements in children aged six to fourteen years. Motor coordination is also referred to as the ability to coordinate muscles in a sequence that preserves posture, therefore strength and muscle tone being prerequisites for efficient motor coordination (Cech & Martin, 2012:268). Children aged six to fourteen that develop higher levels of motor control should have the ability to successfully engage in and enjoy more movement opportunities (Lopes *et al.,* 2011:4).

An essential component for learning coordinated motor movements is the ability to make corrections for movements that will follow (Chu, 2017:460). As soon as children start learning a new motor skill, it requires a substantial amount of conscious effort, and they rely on information from all their senses, including the proprioceptive system (Chu, 2017:460). Information about the limb's position, speed and force exerted by the limbs are regulated by the proprioceptive system and combined with information from other senses, including visual and tactile systems (Chu, 2017:460). This information is then used to correct and improve the accuracy and quality of the movement (Chu, 2017:460). As soon as motor skill improvement takes place the individual uses less conscious effort and movements become more subconscious and controlled (Chu, 2017:460).

Proprioception plays an important role in the control of fluidity and accuracy of movements (Chu, 2017:460). Proprioception affects rate and timing of movements, as well as the regulation of force exerted by a muscle and the regulation of stretch of a muscle (Blanche *et al*., 2012:691). It therefore affects children's ability to motor plan; maintain fluidity of their movements; use feedback from their actions performed; stabilize their joints; and move their muscles according to the task and orientation of their body in space (Blanche *et al*., 2012:691).

Proprioception underlies motor performance in various movement tasks, and the successful performance of motor skills thus requires proprioceptive control of movements (Wang, Zhu, Kana, Yu, He & Wei, 2019:4).

Motor skills are crucial to a child's physical, social and emotional developmental domains (Cummins *et al.,* 2005:437). Competence in motor movements is a prerequisite for everyday activities and essential to physical activity performance (Stodden *et al.,* 2008:298). Children with difficulties in these motor skills are less likely to participate in movement situations, like team or individual sports and even recess at school. Children with motor skill difficulties will tend to remain sedentary, which can impact their motor skill development negatively and influence their health-related wellness, therefore it is important to address their motor skill coordination and development (D'Hondt, Deforeche, Vaeyens, Vandorpe, Vandendriessche & Pion *et al.,* 2010:7). Coordinated motor skills are essential for the execution of fundamental movement skills (FMS) (Goodway, Robinson & Crowe, 2010:17). FMS consist of locomotor skills such as walking, where the body moves through space, as well as object control skills, like manipulating objects using the body to perform a coordinated motor action and stability skills like balancing that require the use of proprioception in the body (Goodway *et al.,* 2010:17). Competence of FMS during early childhood is crucial for participation in games, sport and other activities of daily living (Goodway *et al.,* 2010:17). Good proprioception and kinesthesia underpin coordinated motor skills in boys and girls, which further impacts fundamental motor skill execution, sport participation and other health-related factors.

1.1.3 Gender differences and the proprioceptive system

As previously stated, the proprioceptive system plays a foundational role in other developmental areas of the child. The effect and influence gender differences have on the proprioceptive system has however not yet been established, but studies have related gender differences to motor development of children (Thomas & French, 2000:275).

According to Tarakci and Tarakci (2016:3) the proprioceptive system needs to effectively relate information to the brain in order to maintain posture and produce movement also known as motor movements. It can therefore be said that the proprioceptive system and motor development are interrelated. Gender differences in motor development appear during each stage of a child's developmental processes (Raudsepp & Pääsuke, 1995:294). Previous studies have shown that performance of a motor task, similar to the ones used to evaluate the proprioceptive system, favour boys in early childhood (Thomas & French, 2000:260). Performance increases within each child during the years of childhood development, but boys remain at a slight advantage to girls (Thomas & French, 2000:260). Research in the United States of America (USA) regarding motor skills have shown that boys are more proficient when it comes to object control skills like kicking and catching, whereas for locomotor skills such as running and jumping, no significant differences between girls and boys were reported (Spessato, Gabbard, Valentini & Rudisill, 2013:916-923). Researchers in Southern Brazil investigating general motor skill performance like running, catching and kicking, reported that boys performed significantly better than girls in all of the items tested. Girls did however improve with age, with the exception of ages five to eight, where their performances were relatively stable (Spessato *et al.*, 2013:916-923). Research done in South Africa in the Limpopo province reported no significant motor skill performance differences between six- to nine-year-old boys and girls (Meyer & Sagvolden, 2006:5-10). Venter, Pienaar and Coetzee (2015:179) did a study on South African children aged three to five in Potchefstroom, North-West regarding their gross motor skills and found significant differences in coordination skills (aiming and catching) of boys and girls and reported that boys performed better than girls in coordination skills.

Girls and boys have very slight physical changes prior to puberty where changes occur earlier in girls than in boys between the ages of six and fifteen years (Zheng, Suzuki, Yokomichi, Sato & Yamagata, 2013:3-4). Research has also shown that possible biological differences that affect motor skills between girls and boys are very minimal before the onset of puberty (Spessato, *et al.,* 2013:917). No current studies around the world and especially in South Africa could be found on the relationship between gender differences and specifically the proprioceptive system.

Other factors that can be taken into consideration that might have a possible influence on gender differences of children are environmental influences, which form part of the child's perceptions and perceived experiences (Thomas & French, 2000:261). Perception can be defined as an acquired skill and relies on learning opportunities provided as well as the experiences received (Van Wyk, Coetzee & Pienaar, 2017:651). Bias can also be an explanation for gender differences in children, specifically in terms of activity-specific bias. For example, the assumption that boys mainly prefer manipulating objects and playing with balls, while girls like to skip rope (Spessato *et al*., 2013:917). The bias of these specific activities for boys and girls, as well as the bias in society of gender specific roles can be categorised as a socio-cultural aspect (Spessato *et al.,* 2013:917).

As proprioceptive and kinesthetic abilities of developing children are foundational to many developing aspects, irrespective of possible gender differences, it is essential to determine these abilities by means of appropriate tests or evaluations.

1.1.4 Proprioceptive/Kinesthetic coordination testing

Proprioceptive testing has mainly been done on clinical level where clinicians prefer to test proprioception using custom-built devices or costly computer programmes (Sayar & Űnűbol, 2017:32). These methods aren't always cost effective and feasible for field testing of proprioception and kinesthesia on groups of children still developing. Recently researchers have used instruments like goniometers, inclinometers or pressure sensors to assess proprioception in clinical settings (Sayar & Űnűbol, 2017:32).

Other procedures for testing proprioception include the threshold for detection of passive motion (TTDPM), which is a controlled machine that moves an isolated limb in a predetermined direction using different speeds to detect proprioception around a joint (Han *et al.,* 2016:83-84). The joint position reproduction (JPR) is also used for assessing proprioception and is conducted under active or passive conditions for limb movements (Han *et al.,* 2016:84). The Active Movement Extent Discrimination Apparatus (AMEDA) is used for assessing active movements, and fine movement displacement distances, moving the limb and then returning it to the original position (Han *et al.,* 2016:84-85). Another method used include the Comprehensive Observations of Proprioception (COP) criterion-based tool. This tool measures proprioceptive functions namely behaviour and sensory-motor abilities, which include postural control, the ability to control a muscle and mobility as well as motor planning (Blanche *et al.,* 2012:692,696). It is an observational tool which observes a child during free play, and it consists of a questionnaire (Blanche *et al.,* 2012:692). It is not used to replace proprioceptive assessments but rather to assist them (Blanche *et al.,* 2012:696). Non-clinical methods are also used and include the following: observation of muscle tone when the child is in the sitting or standing position, motor planning (touching thumb to other fingers in order to make a circle with the thumb and other fingers, finger-to-nose test, child touches their nose with their index finger **(**Sayar & Űnűbol, 2017:32), moving a limb against resistance, using isolated movements to assess single joint movements as well as eye movements, ability to detect passive movements with eyes closed and the ability return a joint to a predetermined position. All these methods have been described according to Tarakci and Tarakci (2016:6-7) except for the finger-to-nose which was done by Sayar and Űnűbol in a study (2017:32). Furthermore, other non-clinical methods for proprioception testing has also been identified by Cheatum and Hammond (2000: 195-202), they are as follows: Angels-in-the-snow, this consists of eleven body movements in order to test the sufficiency of the proprioceptive system, Rhomberg – a stationary balance task, repeating copying, involves the child to copy positions of the examiner, finger-to-nose (as described above by Tarakci and Tarakci (2016:6-7) and lastly, the shoulder height arm lift task, which evaluates body schema.

Testing proprioception and kinesthesia on the unique South African population is also a challenge as the population is mainly of low to middle socio-economic status (SES). Substantiated by the 2016 South African census and the results thereof show clearly that the South African population comprises of mainly low to middle income households with high income households not being a high percentage of the population (Statistics, South Africa, 2016:81-96). It is therefore necessary to develop tasks that can be tested on children in low, middle and high socio-economic areas.

1.2 Problem statement

The proprioceptive system forms the building blocks for knowing where one's limbs are in relation to space and the environment surrounding oneself (Goble, Lewis, Hurvitz & Brown, 2005:156). Magill and Anderson (2017:122) state that proprioception also plays an immense role in the coordination of the body and segments of the limbs in the body, more specifically with regards to postural control as these movements require proprioception. It is also stated that proprioception together with tactile information needs to provide the necessary information to the central nervous system in order for postural control to occur, and therefore in order for motor movements to successfully take place (Magill & Anderson, 2017:122). If problems arise in the proprioceptive system - this can in turn cause problems with performing motor movements successfully, as previously stated by Chu (2017:460).

The literature above highlights the importance of a well-functioning proprioceptive system. Furthermore, it is clear that problems or delays of the proprioceptive system can negatively impact various developmental domains of children, such as the development of coordinated motor skills. To address proprioceptive problems or delays, it firstly needs to be identified through standardised and population appropriate tests or evaluations. Although clinical testing of the proprioceptive system has been researched quite extensively (Goble *et al*., 2005:155-170; Han *et al*., 2016:86; Wong *et al.*, 2012:3313-3321), no research could be found on norms for kinesthetic coordination task values, especially in South Africa. Many of the assessment techniques used are either custom built or costly computer programmes and are therefore not feasible to use in the field on large groups of children from different socio-economic backgrounds. Evaluating the kinesthetic coordination abilities of children using an evaluation tool suitable for children in Mangaung, Motheo district, which is a representation of the South African context, where many children live and attend school in low socio-economic areas, is needed.

Limited research could be found on gender differences and proprioceptive abilities of children, with little published evidence available on proprioceptive abilities of South African children. Although there are existing proprioceptive system tasks (Cheatum & Hammond, 2000:195-202) which can be executed outside the laboratory, further research will assist in establishing norms for kinesthetic coordination tasks. Results will potentially provide a much clearer picture of the type of kinesthetic coordination problems present, as well as the expected level of kinesthetic coordination abilities of children within the South African population in the Manguang, Motheo district.

1.3 Aim and objectives

The aim of this study was to establish norms for kinesthetic coordination tasks in six-year-old children in the Mangaung, Motheo District, South Africa, and to determine if the kinesthetic coordination abilities of these six-year-old boys and girls differ.

To meet the aim of this study the set objectives included:

1.3.1 Establishing kinesthetic coordination tasks norms for six-year-olds in the Mangaung, Motheo District, and

1.3.2 to establish if kinesthetic coordination differences exist in six-year-olds, regarding school quintiles, gender and hand dominance.

1.4 Methodology

More information on the specific methods regarding participants, measuring instruments, procedures and statistical analysis, are provided in the articles (Chapter 3 and 4).

1.5 Ethical considerations

Ethics approval was firstly obtained from the Health Sciences Research Ethics Committee (HSREC) of the University of the Free State (UFS) (UFS-HSD2020/0143/210), from the Free State Department of Basic Education (DoBE), the principals of the various schools involved and parents of the children that participated in the study. Assent from the children was also obtained prior to commencement of data collection. Principal and parents (consent) forms were translated in three languages: Afrikaans, English and Sesotho and issued in accordance with what was asked for by the schools' principals. Assent forms were read and fully explained to all participants involved, the assent form included illustrations to ensure that the children knew what was expected of them. They also signed the forms themselves by writing their names or making a mark which is the equivalent of writing their names. Their names were not recorded anywhere on the test forms or anywhere else prior to and during data collection. They were also made aware of the fact that they have the right to withdraw their consent at any given time during the study should they feel like they need to without the incurrence of any penalties. They were also made aware of the fact that no remuneration was to be given for the participation in the study.

Privacy and confidentiality were of utmost importance and was ensured throughout the data collection. Test forms as well as consent and assent forms were secured in a private and safe location to which only the main researcher involved had access to. Data collection and analysis was done on a laptop in a password protected Microsoft Excel spreadsheet. Adequate training of the field workers and interpreter was done to ensure proper quality data collection. Optimal testing time was allocated at each school when data was collected, and handling of the data was quality controlled.

1.6 Layout of this dissertation

Numbers one - five represent chapters

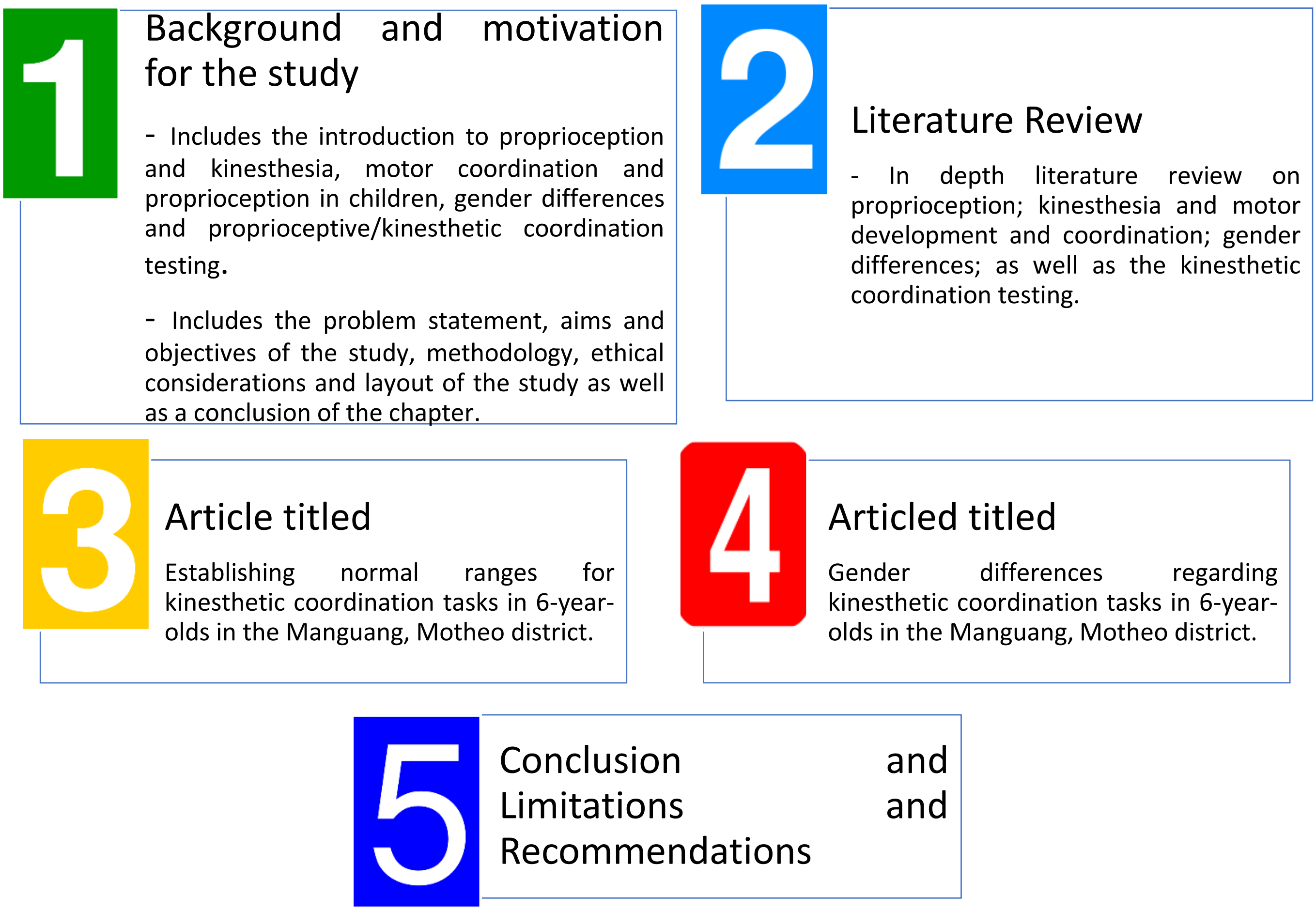

Figure 1: Layout of the Dissertation

This dissertation is profiled in five chapters. Chapter one helps to establish the main topic, problem statement; aims and objectives of the study, methodology of the study, ethical considerations taken, layout of the study as well as conclusions and references. References are found at the end of each chapter. References for chapters one, two and three are done according to the Harvard Referencing Style, where chapter four's references are done according to the American Psychological Association style (APA) as required by the journal guidelines. Chapter two focuses on the literature review highlighting the main topic of the study, along with supporting topics and a conclusion. Chapters three and four are written in article format and done according to the journal in which they are likely to be published in. Chapter three, article one titled: **Establishing normal ranges for kinesthetic coordination tasks in 6-year-olds in the Mangaung, Motheo district** is written according to the submission guidelines for the *South African Journal of Childhood Education* (Appendix O). Chapter four, article two titled: **Kinesthetic coordination abilities in 6-year-olds: School quintile, gender, and dominance differences** is written according to submission guidelines for the *Early Childhood Development and Care Journal* (Appendix F). Lastly, chapter five provides a collective summary of the study along with a collective conclusion based on the study and limitations and recommendations. Thereafter, a list of appendices and the appendices used follow in chronological order.

The dissertation is submitted in article format, as approved by the UFS according to its guidelines for postgraduate dissertation submission. All references are done according to the Harvard Referencing Method.

1.7 Conclusion

Chapter one introduced the proprioception system along with kinesthesis, motor coordination and proprioception was highlighted, along with gender differences of the proprioceptive system and an overall introduction to proprioceptive/kinesthetic testing. The main aim and objectives of the study was established, and this called for a greater in-depth literature review on proprioception, kinesthesis, motor control and coordination as well as development of children. An elaboration of this literature review will follow in chapter two.

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CHAPTER 2: LITERATURE REVIEW

This literature review contains an in-depth discussion and elaboration on the proprioceptive system and on kinesthesia. A discussion on the development of a child from early childhood to later childhood (briefly discussed), is included as this forms the basis of knowledge needed for why six-year-olds were used in this dissertation. Following this, the role of sensory systems, including kinesthesia, on children's overall development, is also discussed. Other important aspects relevant to this study include sufficient motor development, motor coordination and motor control of the six-year-old child. Findings on these topics are therefore also elaborated on in depth. A discussion on socio-economic status (SES) and its influence on the schooling environment, as well as hand dominance and its relation to children's motor coordination, follow. Lastly, literature on kinesthetic coordination and proprioceptive testing, as well as the tasks items used are elaborated on. The review ends off with a conclusion on all aspects related to the main purpose of the study.

2.1 Introduction

From the moment of conception early childhood development takes place, and the rate of development at this stage surpasses any other stage of life (Shonkhoff & Phillips, 2000:3). The early years of life lay a foundation for the development of skills, learning and well-being (Shavit, Friedman, Gal & Vaknin, 2018:26). Childhood development is shaped by an interaction amongst biology of the child, therefore, highlighting an interaction amongst a child's sensory systems and their surrounding environment (Shonkhoff & Phillips, 2000:22; Das, 2020:3286). Childhood development includes social, cognitive, language, emotional and physical skills (Brinkman, Gregory, Goldfeld, Lynch & Hardy, 2014:1092-1093). Children use their senses to learn about the world around them, and these senses are directly linked to emotional, cognitive and physical development (Tarakci & Tarakci, 2016:2). When children development emotionally, they do not always have control over their emotions, but they do learn how to behave in socially accepted manners (Das, 2020:3288). Cognitive development develops during play situations and children learn how to use and develop language skills (Das, 2020:3288). Physical development refers to a child physically developing in a proximodistal (from their inside to their outside) and cephalocaudal (from the top to the bottom) manner (Das, 2020:3288), while this development is distinctively visible during early childhood (Das, 2020:3288). Life is made-up of sensory experiences and movement situations, which occurs in a physical environment (Adolph & Hoch: 2018:26.7). Childhood development is exceptionally important as the early stages of motor development forms the basis for fundamental movement skills (FMS), as well as academic skills which children will need later on in their lives (Anderson, 2018:12). The second largest system in the body referred to as the proprioception system (Tarakci & Tarakci, 2016:3), is exceptionally important in the development of children and forms the basis of this dissertation.

2.2 Proprioception and kinesthesia

In 1833, Sir Charles Bell was the first to describe proprioception as the "sixth sense" within the body (Bell, 1833:195), referring to the sense of position of the limbs and action of the limbs (Hillier, Immink & Thewlis, 2015:933). A further sixty years later in 1880 another term known as "kinesthesia" or likewise referred to as "muscular sense" was introduced by anatomist and pathologist Henry Bastian (Bastian, 1887:543). In 1906 an English neurophysiologist Sir Charles Sherrington defined proprioception as a combination of the Latin term "proprius" meaning one's own, and the term "perception" (Sherrington, 1906:150-180). From this he refined the definition of proprioception as the perception of joint and body movement, as well as position of the body or segments of the body in space (Sherrington, 1906:150-180).

Proprioception is part of the sensory system and relates primarily to position sense (Laskowski, Newcomer-Aney & Smith, 2000:324). This position sense is comprised of static and dynamic sense (Laskowski *et al.,* 2000:324). There are also two levels of proprioception: conscious (voluntary movements) and unconscious (reflexive movements) (Laskowski *et al.,* 2000:324). Proprioception primarily originates from mechanosensory neurons that are distributed throughout the body, this is collectively referred to as proprioceptors (Tuthill & Azim, 2018:187), found in muscle spindles, Golgi-tendon organs and joint receptors (Proske & Gandevia, 2012:1653-1661). Each of these proprioceptors will now be briefly discussed.

Primary and secondary muscle spindle afferents known as type 1a and type 2 muscle fibres make up the composition of muscle spindles and therefore consist of a bundle of muscle spindle fibres contained within a spindle-shaped capsule and include type 1a and type 2 muscle spindle fibres (Delhaye, Long & Bensmaia, 2018:1577; Magill & Anderson, 2017:116-117). Each afferent pathway contains a combination of muscle spindle fibres, and these different combinations of afferent pathways lead to different response properties (Delhaye *et al*., 2018:1577; Magill & Anderson, 2017:116-117). Responses to passive movements like sitting depend on muscle length and the rate at which the muscle length changes, whereas the response to active movements, like walking are much more complex (Delhaye *et al*., 2018:1577-1578; Magill & Anderson, 2017:116-117). Muscle spindles are proprioceptors but also have important non-proprioceptive roles that assist in reflexes, which control posture and locomotion (Proske, 2015:179).

Golgi-tendon organs are found in nerve endings of muscle tendon junctions and provide information about tension during contraction and stretching of muscles (Lagercrantz, Hanson, Ment & Peebles, 2010:130-131). The Golgi-tendon specifically detects tension in the muscles generated by the contraction or the stretching of a muscle and responds to changes in force of a muscle to stimulate motor neurons in order to execute a motor action (Cech & Martin, 2012:215; Magill & Anderson, 2017:117).

Joint receptors located in joint capsules play an important role in proprioceptive awareness as these receptors respond to pressure applied directly over the joint-to-joint movements as well as contraction of muscles that insert directly into the joint capsule (Delhaye *et al*., 2018:1577-1578). Joint receptors namely Ruffini endings, found in ligaments, constantly receive information about joint motion signalling position as well as rotation of joints, and are responsible for the control of muscles around a joint (Hagert, 2010:3). Joint receptors adapt to responses in joints particularly when the joint involved is near its extreme position (lots of flexion and/or extension occurs), therefore providing signals that potential damage of the joint can occur (Delhaye *et al.,* 2018:1577-1578). Joint receptors are also responsible for signalling spatial relationships in the body relating to orientation of the body parts (Prokse, 2015:180).

As mentioned above, proprioception is based on sensory inputs, modalities and receptors (Valori, McKenna-Plumley, Bayramova, Callegher, Altoé & Farroni, 2020:2). It does, however, not only involve peripheral and central systems of the body, but also make use of other sensory systems including the visual and vestibular systems (Hillier *et al*., 2015:934). The vestibular system detects movement of the head in space and the visual system gives a sense of motion while allowing conscious movement occurrence, which plays a crucial role in everyday tasks such as locomotion (Valori *et al*., 2020:2).

Integrating information about orientation of the head and body from the vestibular system together with joint status derived from the proprioceptive system allows for functioning balance without the use of visual information (Chu, 2017:2). Proprioception is also directly linked to the cerebellum through the spinocerebellar tract, and signals are subconscious and is important for posture regulation, balance and movement fluidity and accuracy (Chu, 2017:2). Research argues that proprioception and kinesthesia are synonymous (Han, Waddington, Adams, Anson & Lui, 2016:81).

Kinesthesia has recently been defined as the sense of position of the joints and the sense of movement of the joints (Han *et al.,* 2016:81). Kinesthesia is initiated by the visual, tactile and proprioceptive systems including sensory and motor aspects (Jameel, Yasmeen & Jokerst, 2019:3). Three sensory inputs make up kinesthesia including: 1) The sense of position and orientation relating to the body and limbs; 2) The ability to identify the motions of all limbs and the rest of the body; and 3) To identify efforts generated by the muscles along with forces that act on the muscles causing movement performance (Jameel et al., 2019:3). Kinesthesia focuses on limb position and movement sense, and it is a part of the somatosensory system that uses conscious bodily perception distributed throughout the whole body (Françoise, Candau, Alaoui & Shiphorst, 2017:2). Kinesthetic sensation describes a deep sensation of joint motion and joint position sense from mechanoreceptors located in the joint capsule, muscle spindles, Golgi-tendon organs and the ligaments around a joint that provides joint kinesthetic sensation and sensitivity (Bhale & Wani, 2019:2187). Kinesthetic sensitivity is the ability of the body to manipulate the skin, muscles and joints to provide movement and positioning of the limbs, which is also known as muscle memory (Jameel *et al*., 2019:3). Kinesthetic sensitivity is needed to perceive direction, perceive how heavy something is and essentially to know where to move the body in space (Jameel *et al*., 2019:4). This ability plays a crucial role in movement execution (Françoise *et al*., 2017:2). Kinesthetic indicators of the muscles, tendons, joints and skin mechanoreceptors integrate neural control and organisation of the limbs and body movements (Jameel *et al*., 2019:3). This sense of movement depends on the joint position awareness and allows information to be integrated to the body in the absence of vision (Jameel *et al*., 2019:3).

2.2.1 The sensory system during the childhood years

Children learn how to move with control and competence, in reaction to challenges faced daily in an environment which is constantly changing (Goodway, Ozmun & Gallahue, 2019:48). A variety of sensory systems help children to develop this awareness of their bodies, and although each of the sensory systems have their own neurological network, pathway and location in the brain, these systems operate in combination (Drury & Fletcher-Watson, 2016:8-9). The five sensory systems include five senses and are elaborated on in the table below (Tarakci & Tarakci, 2016:3):

Table 2. 1: Sensory Systems (Sense, Organ, System, Function and Maturity)

Sense	Sensory Organ	Sensory System	Function	Maturity
Hearing	Ears	Auditory system	Provides information about sounds found in the environment around oneself	The auditory system develops in parts, starting at one to three gestational weeks and continuing up to six months post-natal (Iyengar, 2012:429-430).
Sight	Eyes	Visual system	Provides information about people and objects in space	Children aged nine to twelve perform better in visual tasks and present with less errors, therefore the visual system is said to be fully mature at the

				age of twelve (de Sá, Boffino, Ramos & Tanaka, 2018:75; Peterson, Christou & Rosengren, 2006:459,461).
Smell	Nose	Olfactory system	Provides information about smells	The sense of smell is mature at 12 weeks of gestational age (Sarnat & Yu, 2016:315).
Taste	Tongue	Gustatory system	Provides information about different types of tastes	A girl's gustatory system is mature between the ages of eight and nine, whereas a boy's gustatory system is only mature after the age of nine (James, Laing & Oram, 1997:196).
Touch	Skin	Tactile system	Provides information about the environment and objects (pressure)	The earliest, localised reflex is already mature by nine and a half weeks gestational age, and from there on the tactile system develops throughout age (Humphrey, 1964:127).

In addition to the five sensory systems, two other systems also play a crucial role in the development of children (Tarakci & Tarakci, 2016:3). These include the vestibular and proprioceptive systems:

Table 2. 2: Additional Sensory Systems (Location, Function and Maturity)

System	**Location**	**Function**	**Maturity**
Vestibular	Inner ear	Provides information about where the body is in space and helps maintain equilibrium of the body	The vestibular system reaches adult like levels at the age of seven to eight years and improves with age up until twelve years (Steindl, Kunz, Schrott-Fischer & Scholtz, 2006:481; Peterson *et al.,* 2006:461).
Proprioceptive	Muscles, joints and tendons	Provides information about the body and segments of the body in space and the movements thereof	The proprioceptive system is said to have reached maturity by the age of nine (de Sá e*t al.,* 2017:76).

The development of the proprioceptive system begins in utero and is already well developed by mid-fetal life. Movements like tapping, stretching or changes in the amniotic fluid pressure in turn causes the fetus to respond, which then facilitates the development of the proprioceptive system (Cech & Martin, 2012:218). Evidence shows that after birth infants imitate mouth opening and tongue protrusion in the same way that a child handles objects, with infants producing movement to gain proprioceptive information (Cech & Martin, 2012: 221). Children up to the age of two years make significant proprioceptive errors as this system is not yet fully maturated or stabilised (Bremner, Holmes & Spence, 2012:33). Recent literature has shown that the proprioceptive system and how it responds to visual and vestibular information are relatively stable in eight-year-old children (Valori et al., 2020:16; Tarakci & Tarakci, 2016:4). In contrast a study done by de Sá and co-workers (2017:76) stated that the proprioceptive system only reaches full maturity by the age of nine.

Most body movements in daily activities are automated and therefore, conscious attention is required to learn more complex movement skills by developing new patterns of movements (Han *et al*., 2016:81). According to Han *et al*. (2016:81) appropriate processing of proprioceptive information is needed in order for this to occur successfully. Intact proprioception is thus essential for motor control, muscle tone and execution of voluntary motor movements (Holst-Wolf, Yeh & Konczak, 2016:2).

In summary, proprioception and kinesthesia are responsible for the production of coordinated movements. As children grow and develop their movements become more coordinated through experience, practice and interaction with the environment. The overall development and motor development of the young child will now be discussed as this discussion provides a clear explanation as to why it is important to master kinesthetic coordination tasks in especially the six-year-old child.

2.3 Child development

The earliest years of life, starting in utero, are especially important for development of children (World Health Organisation (WHO), 2018:1). The brain develops rapidly, and the first few years are therefore a critical period for the fetus and the child to receive the needed nurturing care (WHO, 2018:1). In utero and early childhood, the fetus and child are most sensitive to changes in their bodies and their immediate environment. This includes stimulation in the form of talking, pointing, enabling and demonstrating – with or without objects, as well as smiling with/to them in order for developmental changes to occur (WHO, 2020:v). These changes include cognitive, physical, language, socio-emotional, and motor development domains, which start from the moment of conception until more or less eight years of age (World Health Organisation, 2018:1). Children reach developmental potential when they have acquired all the developmental competencies needed for academic, economic, behavioural, socio-emotional accomplishments (Black, Walker, Fernald, Andersen, DiGirolamo & Lu *et al.,* 2016:3). According to Black *et al.* (2016:3) multiple factors influence the acquisition of these developmental competencies. The WHO (2018:1) lists the following influential factors: good health, adequate nutrition, responsive caregivers, security, safety, and opportunities for early learning. Development encompasses all aspects of human behaviour and as a result is separated into developmental domains (as listed above) (Goodway *et al.,* 2019:4). All these domains interact with each other and are mutually reinforcing throughout the process of overall development (Black *et al*., 2016:3).

2.3.1 Motor development during the childhood years

During the childhood years motor development is exceptionally important as children learn locomotor skills (movement), how to manipulate objects and maintaining and stabilising their balance, while simultaneously exploring the environment around them (Khalaj & Amri, 2013:659; Park, 2015:3184). Motor development can be defined as the continuous change in motor behaviour throughout life, brought about by interactions among the requirements for a movement task; biology of the individual; and conditions of the learning environment (Goodway *et al*., 2019:4). Figure 2.1 below visually represents the relationship between motor development and the interaction amongst a movement task, the biology of the individual and the condition of the learning environment (Goodway *et al*., 2019:4).

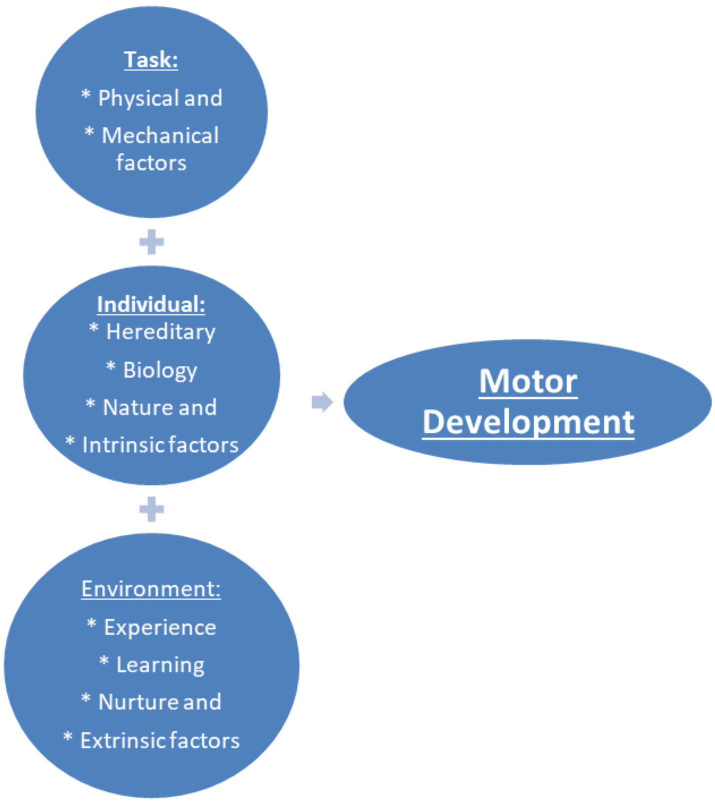

Figure 2.1: Motor Development and the factors that influence motor development

Motor development depends on the task, the individual and the environment. In Figure 2.1, the task relates to the performance of a set motor task, which involves the physical and mechanical factors of the child, as well as the physical development of their sensory systems.

The individual relates to hereditary factors, biology, nature and intrinsic factors of, and it states that childhood is marked by steady increases in height, weight and muscle mass (Goodway *et al*., 2019:160). Lastly, the environment includes experiences and learning opportunities which are needed for the child to learn and refine motor skills. The environment also involves nurture and extrinsic factors which influences the development of a child's motor skill abilities. Development in children is divided into phases, while placing emphasis on the fundamental movement phases as this is the phase in which children aged six falls into.

2.3.2. Phases of motor development

Different phases of motor development influence how children typically develop. According to Goodway and co-workers (2019:48-63) the various phases of motor development are as follow:

1. Reflexive Movement Phase: Utero until one year

This phase refers to reflexes that are involuntary and subcortically controlled movements that form the basis for motor development. These reflexes help the infant to gain information about their environment.

2. Rudimentary Movement Phase: Birth until two years

This phase includes the first forms of voluntary movements which are characterised by highly predicable sequences of appearance. Movements involve stability tasks (controlling the head, neck and trunk muscles), manipulative tasks (reaching, grasping and releasing) and locomotor tasks (creeping, crawling and walking).

3. Fundamental Movement Phase: two to seven years

This phase is a time where children are actively involved in exploring and experimenting with their bodies movement potential. This phase is also the phase relevant to the current study as this is the age where they learn most of their FMS. It is also these FMS which are necessary for especially six-year-old children (postural control, balance, coordination and locomotion to mention a few) in order to successfully enter the formal school setting. These children discover ways for stabilising locomotor and manipulative movements in isolation and then in combination with each other. Children develop these skills by learning how to respond with motor control and movement competence to a variety of stimuli. FMS are also important components of daily living.

4. Specialised Movement Phase: Seven to Fourteen years

This phase refers to a variety of complex movement activities required for daily living, recreation and sport. In this phase fundamental stability, locomotor and manipulative skills are refined, combined and elaborated upon to use in increasingly demanding situations. This phase depends mainly on a variety of task, individual and environmental factors.

Childhood can be divided into three periods namely, early childhood, middle childhood and later childhood (Goodway *et al*., 2019:161). Early childhood, middle childhood and later childhood will be discussed below although only early childhood is applicable to this dissertation, middle and later childhood also forms part of the development of a child and will be discussed briefly.

2.3.3. Early childhood (Zero to Eight years)

Growth and development go hand-in-hand during early childhood (Sudarmilah, Saputra, Arbain & Murtiyasa, 2021:2) and is very important in the early childhood years (Marra, 2020:1). During early childhood years, growth is not as rapid as it is in infancy; it slows down after the first two years but maintains a constant rate until puberty (Goodway *et al.,* 2019:169). Gender differences may be seen in height and weight but are very minimal in this regard (Goodway *et al*., 2019:169). Physical development takes place from head to toe (cephalocaudal), while motor skills develop from the central body to the peripheral body parts (proximodistal) (Das, 2020:3288).

Cognitive development is a sub-component of play, and play is the primary mode by which children learn about their bodies and their movement capabilities therefore using their cognitive abilities (Goodway *et al*., 2019:169). They also learn to use language during play which enhances cognitive development (Das, 2020:3288). Play is characterised by spontaneous, self-initiated and self-regulated activities of children, play is relatively risk free and not goal oriented (Verenikina, Harris & Lysaght, 2003:99). It is also intrinsically motivated, and children are actively involved in creating and controlling play situations (Verenikina *et al*., 2003:100). Play affects children's well-being and advances their social, cognitive and emotional development (Verenikina *et al*., 2003:100). Emotional development is also observed during early childhood, and children show strong reactions to things that can be seen as minor incidents because they have not yet mastered the art of controlling their emotions and only manage to do so later on in their childhood (Das, 2020:3288).

The ability to move effectively during early childhood is a result of multiple domains of development (like cognitive, affective, emotional and social) as discussed above (Capio, Chan & Li, 2021:1). Children learn how to move their bodies in space by developing FMS, which forms the foundation in order for more complex skills to occur later on (Schmutz, Leeger-Aschman, Kakebeeke, Zysset, Messerli-Bürgy & Stülb *et al.,* 2020:2). The early childhood years are therefore essential for refining movement tasks, especially in the fundamental movement stage (Goodway *et al*., 2019:165).

2.3.4 Middle childhood (Nine to Twelve years)

Growth from the age of eight and onwards is rather slow, however, physiological development is faster in girls than in boys (Goodway *et al.,* 2019:170). A mid-growth spurt occurs between six to eight years of age, and researchers state that during this mid-growth spurt motor performance and motor coordination are interconnected (Dos Santos, Baxter-Jones, Reyes, Freitas, Henrique & Chaves *et al.,* 2019:1).

FMS should be refined in the early childhood years and mastered at the start of the middle childhood years where more specialised skills start to develop (Goodway *et al.,* 2019:170). During the middle childhood years better, motor coordination increases children's participation in physical activity and games (Adriyani, Iskandar, Camelia & Bandung, 2019:122). Motor coordination is associated with higher physical activity levels, with a significant difference between ten-year-old boys and ten-year-old girls in terms of coordination being reported (Adriyani *et al*., 2019:124). Results of the study showed that boys have a higher level of physical activity and coordination levels than compared to girls (Adriyani *et al.,* 2019:125). It is said that strength and motor performance improve in the middle childhood years and adolescence but is still not uniform for all tasks (Malina, Bouchard & Bar-or, 2004:218). Strength and muscular endurance increase linearly with age until thirteen and fourteen years in boys and sixteen and seventeen years in girls (Malina *et al.,* 2004:218). Coordination (specifically throwing skills) increases markedly for boys with age and only slightly in girls (Malina *et al.,* 2004:221). Balance improves with age, while girls perform better than boys in balancing skills (balance-beam walk) (Malina *et al.,* 2004:223). The middle childhood years (nine till twelve) are foundational for later childhood years and depend greatly on the refined development of motor skills and motor coordination (Adriyani *et al.,* 2019:125). However, middle childhood is not the main focus of this dissertation and therefore it is only briefly elaborated on.

2.3.5 Later childhood (Twelve to Eighteen years)

Later childhood forms part of childhood development but is not the focus of this dissertation and is therefore only mentioned briefly. Later childhood can also be referred to as adolescence (Steinberg, 2014:8). Adolescence marks the period of puberty (transition into adulthood) (Steinberg, 2014:46). FMS are refined in later childhood years (Logan, Webster, Getchell, Pfeirrer & Robinson, 2015:423). Children from aged twelve to eighteen have high competency in FMS as proven by studies done on children during this age range (Logan e*t al.,* 2015:423). The study of Logan et al. (2015:417) also showed a positive correlation between FMS and physical activity and states that children in later childhood who have higher competencies in FMS have increased physical activity levels, while this tracks into adulthood. A study done by Van Niekerk, Du Toit and Pienaar (2015:1332) on children aged thirteen to fourteen, relates motor proficiency (FMS) to academic achievement in later childhood and states that motor proficiency influences academic achievement.

2.4 Child development and the South African environment

The environment a child finds themselves in will influence their development, as stated by Bronfenbrenner's ecological systems theory (1974:1-5). This environment refers to the child's ecology, which consists of their immediate setting such as their home, school, playground, or street. Every setting is in turn viewed by the physical environment, the people, their role and relationships towards the child, and activities and social interactions of the child (Bronfenbrenner, 1974:2). Another aspect which shows relation to the child and their environment is the support structure of the child. This includes amongst others the house the child grows up in, and the health and homecare services in the community (Bronfenbrenner, 1974:2). The immediate environment of the child can have a direct link to the socio-economic status (SES) of the parent/guardian and therefore the child and their development.

SES can be seen as a combination of measures of different economic and social factors which include educational level, housing (amenities and condition), income and occupation (Galobardes, Shaw, Lawlor, Lynch & Smith, 2006:8). South Africa is classified as a developing, middle-income country (World Economic Situation and Prospects (WESP), 2014:146, 148). More than a fifth of children in South Africa in 2013 have been reported to go to bed hungry, indicating they live in poverty (Timaeus, Simelane & Letsoalo, 2013:275). School-age children in South Africa are divided more-or-less equally between rural and urban areas; however, it has been found that educational attainment was far worse in rural areas than urban areas (Timaeus *et al.*, 2013:275). Socio-economic status thus influences children's schooling to a great extent (Timaeus *et al.,* 2013:275). Schools in South Africa work on a quintile ranking system between one and five, where schools in the lowest quintiles (one and two) receive the greatest government subsidy (allowance of money) per child (Maistry & Africa, 2020:2). Low-income schools are ranked as quintile one and two, the middle range of schools is classified as quintile three, and affluent schools as quintile four or five (Mestry, 2014:859). Quintiles one to three schools are no-fee schools, which means they receive all their funding from the government, including finances for stationary, textbooks, electricity, water and sanitation, as well as repairs and maintenance (Maistry & Africa, 2020:2). It is said that the lower quintile schools are not allowed to charge school fees, whereas quintile four and five schools are allowed to charge fees (Maistry & Africa, 2020:2).

Children in lower quintile schools in South Africa have a lack of overall well-being, which relates to poor nutrition, poor living environments and poor health care (Smith, 2011:93).

They also have a lack of learning materials like books and stationery (Smith, 2011:93. They have a high child to teacher ratio which means that there are more children placed in a classroom than a teacher can effectively handle (Smith, 2011:93). Lower quintile schools also have little to no access to electronics like televisions and computers to assist in learning (Smith, 2011:93). These factors are all in comparison to higher quintile schools (Smith, 2011:93).

It is reported that children in higher quintile schools perform better academically than children in lower quintile schools (one to three schools) (Ogbonnaya & Awuah, 2019:115). A study done by Tomaz, Jones, Hinkley, Bernstein, Twine & Kahn *et al.,* (2019:691) indicate that preschool children from rural low-income status outperformed children from both urban low and urban high-income status, with regards to their gross motor skills. However, the gross motor skills acquired are not sustainable throughout their school careers as the school environment is not equipped to be able to maintain these skills (Tomaz *et al.,* 2019:693). Researchers argue that this could be a result of insufficient time and opportunities given to practice these gross motor skills, or due to a lack of equipment on the playground (van der Walt, Plastow & Unger, 2020:6). Research done in South Africa (Pienaar, Visagie & Leonard, 2015:328) also states that opportunities for children in lower SES areas are needed to establish their gross motor skills (especially kicking and catching a ball).

Children make use of their surrounding environment in order to accomplish motor competency and move in a coordinated way. Consequently, under-stimulating environments can negatively affect their motor skill development.

2.5 Motor coordination and motor control

Motor coordination and control produce purposeful coordinated movements, and encompass the activation and coordination of muscles, joints and limbs in order to perform a newly learned motor skill or to execute an experienced motor skill (Saha & Saha, 2013:1). Motor coordination harmonises the nervous and musculoskeletal systems, resulting in rapid, accurate and balanced motor responses (Fernandes, Scipião Ribeiro, Melo, de Tarso Maciel-Pinheiro, Guimarães & Araũjo *et al.,* 2016:1). Motor coordination is also used as a term that involves various aspects of motor competency (Lopes, Stodden, Bianchi, Maia & Rodrigues, 2011:2).

Motor skill competence is important for children's general gross and fine motor development (D'Hondt, Deforche, Vaeyens, Vandorpe, Vandendriessche, & Pion *et al.,* 2010:1). Children need a combination of these motor skills ranging from jumping and running to drawing and writing, in order to meet the demands of home, school, sport and other social environments (Van der Fels, te Wierike, Hartman, Elferink-Gemser, Smith & Visscher, 2015:697-703). Van der Fels *et al.,* (2015:697-698) and Goodway *et al.,* (2019:15) categorise motor skills into the following five categories:

1. Gross motor skills make use of large muscles to perform a motor movement such as running and jumping, and also include physical abilities like muscle strength, endurance and balance, which are needed to perform a motor task (Goodway *et al.,* 2019:15).

2. Fine motor skills make use of several small muscles to execute a movement task such as writing and drawing, where fine motor precision and integration are needed (Goodway *et al.,* 2019:15).

3. Bilateral body coordination refers to the ability to use both sides of the body in an integrated and skilled manner (Balakrishnan & Rao, 2007:55). The development of bilateral coordination paves the way for further motor development (Balakrishnan & Rao, 2007:55). Theory of developmental principles state that unilateral movements (require the use of only one limb to move at a time) develop first, then homolateral movements (movement of limbs on the same side of the body) followed by bilateral movement coordination, and finally contralateral movements (using the opposite sides of the body) (Cheatum & Hammond, 2000:21-22, 195-199). Poor coordination in this aspect result in children not being able to cross their midlines, failure to develop a preferred hand, as well as left-right discrimination confusion (Balakrishnan & Rao, 2007:55).

4. Timed movement skills refer to movements that are simple and repetitive of nature and can consequently be performed more than once, such as catching.

5. Object control skills make use of coordinated movements in order to control an object like kicking a ball.

Children with sufficient motor coordination skills may have more opportunities to participate in physical activities and are better at movement patterns, including motor planning (Ruźbarska, 2016:1). Motor coordination has also been positively associated with cardiovascular respiratory fitness, physical activity, muscular endurance and strength, as well as body mass index (Cattuzo, dos Santos Henrique, Ré, de Oliveira, Melo & de Sousa Moura *et al.,* 2016:128; Chaves, Baxter-Jones, Gomes, Souza, Pereira, Maia, 2015:8883). The contrary is also true where children with poorer motor coordination skills may have less opportunities to participate in physical activities and movement situations such as play (D'Hondt *et al*., 2010:1), leading to sedentary lifestyles (Ruźbarska, 2016:1-2). Increased sedentary time can consequently negatively impact motor skill development, social interactions and health-related opportunities (D'Hondt *et al*., 2010:1).

Children aged six to fourteen years with poor motor coordination have shown significant impairments in daily tasks as stated by de Chaves, Valdivia, Freitas, Tani, Katzmarzyk and Maia (2016:107-114). Daily tasks include self-care and school-based activities, as well as emotional and social interactions amongst their peers. Research done by Adriyani and co-workers (2019:122-126) has shown that children's motor coordination skills can develop through various play situations at recess and participation in life orientation class. It is also reported that children with poorer motor coordination skills also have decreased cognitive functioning and social interaction problems (Adriyani e*t al.,* 2019:125). Inadequate motor coordination can affect overall motor coordination as well as cognitive development, negatively affecting academic achievement (Balakrishnan & Rao, 2007:55).

2.5.1 Motor coordination as foundation for children's academic achievement

Children require the coordination of different skills to be successful in school, as these skills are important contributing factors to academic readiness of young school-going children (six-year-olds) (Pienaar, 2019:8). Research on Brazilian children aged four, six and eight years old, reported that motor coordination problems negatively impact academic achievement

(Cardosa & Magalhães, 2009:119). Six-year-old Portuguese children who have better coordination skills are reported to have a better health profile and therefore improved cognitive skills (Henrique, Bustamante, Freitas, Tani, Katzmarzyk & Maia, 2017:226). A direct relationship between motor coordination and academic achievement was also reported among Spanish school children aged six to nine (Guillamón, Cantó & García, 2020:10-11). Children with good academic achievements also performed better in coordination activities (Guillamón *et al.,* 2020:8). Indonesian children aged three to six years were reported to have poorer gross motor coordination, while they also spend 80% of the school day being sedentary, causing decreased cognitive functioning (Famelia, Tsuda, Bakhtiar & Goodway, 2018:S418). However, in Rio de Janeiro a weak and insignificant association between motor coordination and academic achievement scores were reported in middle school children aged twelve to fourteen years (Chagas, Leporace & Batista, 2016:622624).

In South Africa, a study done on motor proficiency results showed that motor proficiency has a positive influence on academic achievement, whereas SES has a negative influence on the motor proficiency of children during their early academic years (de Waal & Pienaar, 2020:680). This study was conducted on children between the ages of six and thirteen years, in the North-West province of South Africa (de Waal & Pienaar, 2020:673). Another study done in South Africa by Botha and Africa (2020:735-736) on children aged six to seven years, found that motor proficiency contributed to academic performance, especially in regard to reading, writing and spelling abilities. Skills related to reading and writing include bilateral coordination, upper-limb coordination and balance (Botha & Africa, 2020:735). Significant correlations were also found in another South African based study, between the fundamental movement skills (balance, bilateral coordination and spatial awareness) and academic achievement of children aged five to six years old (de Waal, 2019:462). These fundamental movement skills (balance, bilateral coordination, spatial awareness) are not only of importance for academic performance, but also relate to the successful execution of kinesthetic coordination tasks.

2.5.2 Motor coordination and kinesthesia in the six-year-old child

Motor development is associated with almost every aspect of development (Anderson, 2018:12), and is significantly important during the preschool years (Vlachos, Papadimitriou & Bonoti, 2014:16). The age of six is a critical age in children's development since they enter grade one, at this age and will need the necessary skills to establish a strong foundation for their school career.

Six-year-old children should be proficient in most FMS but however, are not (Pienaar, van Reenen & Weber, 2016:12). If a child can execute locomotor, balance, object control, body awareness, and general coordination skills in a coordinated and fluent manner, it is said that these skills are mature, which should be the case at the age of six to seven years (Pienaar *et al.,* 2016:1-15). Motor coordination can be improved and refined from six to thirteen years of age (Lima, Bugge, Pfeiffer & Andersen, 2017:5). Motor skills relate to gross and fine motor skills, including postural control, muscle tone, and motor coordination (Park, 2015:3184). Coleman, Piek & Livesey (2001:95-110) states that kinesthetic ability occurs from ages four to seven, with kinesthetic abilities not being matured until the age of approximately seven years. In contrast to what Coleman and co-workers (2001:95-110) found in a study they did on children aged six to twelve years results found that sensory system integration like kinesthesis is only mature at the age of twelve (Peterson, Christou & Rosengren, 2006:461).

In a study done on Greek children aged four to six years on their motor proficiency, it showed that 25% of the children tested low, 57% average and 18% had high motor proficiency levels (Venetsanou & Kambas, 2016:5). In the North-West province of South Africa, the motor skills proficiency of grade one learners (six to seven-year-olds with a mean age of 6.84 years) were found to be average, although when analysing the data individually, a higher percentage of children showed below average-to-average motor proficiency levels (Pienaar & Kemp, 2014:174). Various administration options of the Bruininks-Oseretsky Test of Motor-Proficiency second edition (BOT-2) were used to determine motor proficiency in both the above-mentioned studies. Results reported delays in motor development as a characteristic seen in six-year-olds, and the authors state that motor delays should be further addressed (Khalaj & Amri, 2013:660). The results of the study also indicated that more than 50% of grade one children are at risk of developing various problems such as perceptual, social and cognitive skill difficulties that are associated with poor motor proficiency (Pienaar & Kemp, 2014:177; Leonard, 2016:3). Another study in South Africa indicated that the majority of six-year-old children still don't fully rely on their proprioceptive skills and a vast majority of six-year-old South African children don't master all the FMS at this age (Pienaar *et al.,* 2016:12). Children with motor difficulties find simple motor tasks challenging, therefore resulting in a decrease of physical fitness development and associated motor coordination backlogs (Chaves *et al.,* 2015:8891). Competence in motor skills is consequently needed for development in most aspects of childhood and, competence in motor control and coordination is especially needed for proper kinesthetic coordination abilities.

2.5.3 Motor coordination gender differences at six years of age

Gender differences in early childhood especially at the age of six, are not very common, a few developmental differences in children of this age do however occur with regard to their motor skills. A study done on 540 typical developing children (272 boys and 268 girls) between the ages of four-and-a-half to six years in Greek geographic regions, reported that girls outperformed boys in balancing skills and manual dexterity skills of the BOT long form (first edition) (Venetsanou & Kambas, 2016:6). Boys, on the other hand, outperformed girls portraying better coordination skills (Venetsanou & Kambas, 2016:6). In another study done in Athens, Greece on children aged six- to nine-year-old results also stated that boys perform better in coordination skills than girls of the same ages (Afthentopoulou, Venetsanou, Zounhia & Petrogiannis, 2018:21). These results are reported after a study was conducted on 142 children, using the Pictorial Scale of Perceived Movement Skill Competence for Young Children (PMSC), as well as the Test of Gross Motor Development third edition (TGMD-3). A possible explanation for the big account in better coordination skills of boys is that boys engage more in object control related games and activities, and therefore they have more opportunities to develop and refine coordination skills (Bardid, Huyben, Lenoir, Seghers, De Martelaer & Goodway *et al.,* 2016:13).

Participants with a mean age of 6.54 years in Italy showed that overall boys did better in their gross-motor skills than girls (Sgrò, Quinto, Messana, Pignato & Lipoma, 2017:1957). In conjunction another study done by Morley, Till, Ogilvie and Turner (2015:153-154) in London, also states that boys outperformed girls with regards to their gross motor skill abilities, especially catching and dribbling. This study was done on 369 children between the ages of four and seven, using the BOT-2 short form (Morley *et al.,* 2015:151). In contrast to these findings, a study done in South Africa on children aged six found that girls have better motor skills than boys of the same age, except in kicking (Pienaar *et al.,* 2016:10).

Regarding balancing skills, it has been reported that children between the ages of three and six, portray no gender differences when their balancing abilities are compared (Jiang, Jiao, Wu, Ji, Liu & Chen, 2018:350). In a study done in Greek geographical regions on children between the ages of five and six, motor and memory skills were assessed (Vlachos *et al.,* 2014:14). Motor tasks included bead threading, shape copying and postural stability (Vlachos *et al.,* 2014:14), with results of the postural stability task relating to this dissertation.

The postural stability task required participants to stand up straight, with arms by their side, blind-folded, while the degree of sway was measured (Vlachos *et al.,* 2014:14-15). The description of this task is similar to the Rhomberg balance task used and described later on in this dissertation. Vlachos and co-workers reported that boys did better in the postural stability (balance) task in comparison to girls of the same age. In contrast to the findings of Vlachos and co-workers (2014:14), a study also done in Greek geographical regions on children of the same age (five to six years) reported that girls portrayed significantly better balancing skills than boys (Venetsanou & Kambas, 2016:2). The assessment tool used to derive these results was the BOT first edition long form, specifically the balance sub-test. (Venetsanou & Kambas, 2016:6). Three- to six-year-old children from South Africa, show that balancing skills were less mastered than locomotor skills and results portrayed that girls performed better than boys in all the balancing items (Pienaar *et al.,* 2016:7-8).

Children aged three to six, are in a critical time of motor development and need opportunities for these skills to develop (Jiang *et al.,* 2018:350). Hand dominance and motor coordination form a part of motor coordination.

2.5.4 Motor coordination and hand dominance

The research findings of Triggs, Calvanio, Levine, Heaton and Heilaman (2000:685) report that hand dominance can only be slightly related to motor proficiency, whereas a more recent study reports contrasting results, stating that right-handers have the tendency to be more proficient in coordination tasks (Reyes, Chaves, Baxter-Jones, Vasconcelos, Barnett & Tani *et al.,* 2019:2250). Hand dominance is more than just being right- or left-handed and represents different patterns of specialisation in the brain which is necessary for the manifestation of specific aspects of cognitive, social, and emotional development (Michel, Campbell, Marcinowski, Nelson & Babik, 2016:2). The establishment of hand dominance in early childhood tend to be significantly related to cognitive and motor skill development (Kaufman, Zalma & Kaufman, (1978:887). Although an old finding, it has recently been substantiated by Michel (2018:18) who also reported that hand dominance is established in early childhood and that it also relates to sensorimotor abilities, as well as cognitive abilities of children (Michel, 2018:20).

Children gain stable hand dominance throughout the six-to-fourteen-month age range and right-handedness predominates (Michel, 2018:182). Contradicting, another study states that during the early childhood years, children aged three to five are still uncertain of their dominant hand (Sharoun & Bryden, 2014:11). It is reported that gender and hand dominance do however not hold significant correlation to execution of motor tasks (Livingstone, Goodkin & Ingersoll, 2010:434). Hand dominance is significantly affected by the end-goal of a task and spatial demands for example: children might use their left hand to eat and their right hand to throw a ball; therefore implying they choose their hand based on the end-goal of the task, it does not change over the course of a child’s lifespan (Gonzalez, Flindall & Stone, 2015:7).

Being able to identify a dominant side stands in relation to motor skill aspects, of which laterality and spatial orientation are important (Sharoun & Bryden, 2014:11). Laterality is a component of learning and therefore relates to dominance (Neto, Xavier, dos Santos, Amaro, Florêncio & Poeta, 2013:865). Laterality is defined as the preference of symmetrical body parts like hands and eyes and is therefore, important to establish before children start going to school, hence by the age of six years old (Neto *et al.,* 2013:865). Spatial orientation requires movement around the surrounding environment (Fernandez-Baizan, Arias & Mendez, 2019:17). Spatial orientation is the ability to perceive one's own movements, knowing which movements take place and when they need to take place, while taking into account the position of the body and the head in space, being aware of the sense of gravity of the body, and maintaining balance (Fernandez-Baizan *et al.,* 2019:17). Gardner and Potts (2010:39) stated that spatial orientation is influenced by hand dominance and that spatial orientation correlate with motor abilities (Gardner & Potts, 2010:39). Spatial orientation has a direct influence on motor skills and academic success and is therefore necessary to develop in order for success in school and life (Cameron, Cottone, Murrah, & Grissmer, 2016:9). Therefore, being able to establish hand dominance before children enter the formal school setting is of importance, as it might not only influence laterality and spatial orientation, but also motor skill development and academic achievement. Kinesthetic coordination and proprioception testing is limited and there is a need to establish testing for this.

2.6 Kinesthetic coordination and proprioceptive activity testing

There is no single golden measure of proprioception, since proprioception as a concept in itself is complex and different types of proprioception (proprioception in/around the knee, shoulder and ankle to name a few as well as proprioception in children) can be assessed (Hillier e*t al.,* 2015:935). There are also limited available standardised and norm-referenced assessments of proprioception for use in the pediatric field (Chu, 2017:461). Assessing how a child responds to proprioceptive signals for regulation and modulation is needed in order to characterize a child's ability to participate in daily life activities (Chu, 2017:461). It is also important to assess the child's ability to process and use proprioceptive information for motor control in a comprehensive evaluation (Chu, 2017:461). Various techniques to assess proprioception in a clinical setting utilises complex technical equipment, which is not feasible and accessible to all practitioners (Sayar & Únūbol, 2017:34). This statement is especially true in the South African context, where practitioners in the paediatric field like Kinderkineticists are not able to access costly equipment and parents of the children being tested are not able to pay a vast amount of money for the practitioners to assess their child. Currently the different types of clinical methods used to assess proprioception include:

1) Active Movement Extent Discrimination Apparatus (AMEDA)

According to Han *et al.* (2016:84-85) AMEDA is an apparatus used for assessing proprioception. Tests are conducted using active movements. Participants are given five movement distances from the smallest to the largest to be done three times which gives 15 movements in total. Participants need to do the movement and then return to the starting position (one to five), they then need to do each of each test movements (one to five), without feedback being given as to the correctness of the distance of each movement**.** Participants must therefore use their memory of five movement distances shown to them, to enable them to identify each stimulus and make a judgment according to correct distance (Han *et al.,* 2016:85).

2) The Comprehensive Observations of Proprioception (COP)

COP is a criterion referenced observational tool to measure proprioceptive functions like behaviour and sensory-motor abilities (Blanche, Bodison, Chang & Reinoso, 2012:692). It is used by clinicians to supplement already used standardised measures of proprioception like kinesthesia, standing and walking balance, tests of sensory integration and praxis tests (Blanche *et al.* 2012:687)*.* This tool relates to muscle tone and hypermobility (Blanche e*t al.,* 2012:692). A questionnaire containing questions on proprioception, every-day activities, sports injuries, joint hyper-mobility and other related questions regarding the child is given to the parent to complete. The test takes 15 minutes to administer while the practitioners observe the child during free play (Blanche e*t al.,* 2012:692).

3) Joint Position Reproduction (JPR)

This test is conducted under either passive or active conditions for criterion and reproduction movements (Han *et al.,* 2016:84). A predetermined position is passively/actively presented to the participant for a few seconds. Participants are then required to reproduce the target position sense they previously experienced by indicating the target position by pressing a stop button when the joint is moved in the same range, or by actively moving the joint to the position (Han *et al.,* 2016:84). Participants need to remember the position and place using the same limb (Han *et al.,* 2016:84).

4) The test of kinesthetic sensitivity (KAT)

KAT is designed to test kinesthetic acuity in young children (position and movement discrimination) (Coleman *et al.,* 2001:101). The apparatus used comprises of a masking board with 16 target positions (animals) on top of the apparatus (Coleman *et al.,* 2001:101). Under the curtained board participants hold a stylus which is guided by the assessor from a central position to a peripheral target position. Participants needed to feel which animal they are touching. The stylus is mounted into a single path with a disk cut into it, which can be fully rotated and looked at from any angle. Sixteen animal stickers are then placed onto the baseboard at the target positions. The examiner moves the participant's hand into a position and then sways it from the position. The participant then needs to say at what animal their hand was placed (Coleman *et al.,* 2001:101).

5) Threshold to Detection of Passive Motion (TTDPM)

TTDPM can be used at various joints across the body by means of a controlled machine moving an isolated body segment in a predetermined direction and then using different speeds to test for proprioception force (Han *et al.,* 2016:83-84). Participants are seated or lying down. The body site being tested is isolated by strapping down the other body parts, such as the upper body. Other peripheral information (like visual and tactile information) is not used. The body site under investigation is passively moved in a predetermined direction. Participants are then instructed to press a stop-button as soon as they perceive the movement and direction of their limb. If the direction is wrong, the trial is discarded. Testing is done until three to five successful directions have been given (Han *et al.,* 2016:83-84).

Methods for testing proprioception in children that are non-clinical include the following, as stated by Tarakci and Tarakci (2016:6-7):

- Observation of muscle tone: the child is observed when they sit and/or stand to see if they can keep their body upright against gravity. This gives an indication of gravity position sense. Their muscle tone and posture are also observed when they sit and/or stand (Taracki & Taracki, 2016:6).

- Motor planning: the child is observed when they touch the thumb to other fingers in a sequence at a certain speed, while the thumb and other finger need to make a circle shape. Errors while doing the sequence (a finger skipped), as well as associated reactions (like sticking the tongue out) are noted (Taracki & Taracki, 2016:6).

- Finger-to-nose: the child is observed while they touch their nose with their index finger, while keeping their eyes closed. This test was also used by Sayar & Űnűbol (2017:32) to test for proprioception functioning.

- Moving a limb against resistance: this is done to evaluate strength. Observed movements include lifting arms to shoulder-level and making sure that arms go to the same level each time (Cheatum & Hammond, 2000:201).

- Isolated movements: the child is observed to assess single joint movements and eye movements. Movements include single leg balance and eye tracking, following a pencil with each eye isolated (covering the other eye) (Taracki & Taracki, 2016:7).

- The ability to detect an external passive movement: observations include the ability of a child to detect passive movements of a joint with their eyes closed, like flexing their fingers (making a fist and then relaxing hand and fingers) (Taracki & Taracki, 2016:7).

- The ability to re-position a joint: the limb is placed at a certain point (such as lifting the arm to shoulder level) and then returned to normal position (keeping the arms next to the body). Accurate repetition of the movement by the child is then observed (Taracki & Taracki, 2016:7).

In addition, Cheatum & Hammond (2000:195-202) also identified non-clinical methods to evaluate proprioception as follows:

- Angels-in-the-snow: this consists of eleven body movements which require the arm/s and leg/legs to be moved to a specific position. Movements include single and simultaneous arm or leg movements, as well as bilateral and contra-lateral movements of the arms and legs. Angels-in-the-snow evaluates for an intact proprioceptive system.

- Rhomberg: evaluates balance in a standing position, where the child takes up a standing position with both feet together and eyes closed. Arms relaxed at side.

- Repeated copying: children copy positions (mainly upper body) of the examiner. The examiner performs a certain body movement, and the child then needs to copy what the examiner has done in the correct manner and sequence. This evaluates laterality and directionality.

- Index finger-to-nose (different versions of the finger-to-nose task exist): Cheatum and Hammond (2000:200) states that the child needs to stand with arms raised to shoulder level and extended straight out to side. The child then needs to touch the index finger (preferred arm) to nose and then return to starting position. Alternate movement with arm (non-preferred). Repeat four times. Do with eyes open and eyes closed. Eyes open evaluates the proprioceptive system and eyes closed evaluates vestibular system.

- Shoulder height arm lift: The child needs to be able to lift one arm to shoulder level and then to normal resting position (arm next to body), they need to repeat this in succession each time, returning the arm to shoulder level and back to normal position. This is done with the preferred arm, non-preferred arm and both arms. This method evaluates body schema (defined in glossary).

With the above literature as background, the following movement tasks will be included in the current study to assist in establishing kinesthetic coordination norms: *Angels-in-the-Snow, Rhomberg, Finger-to-nose, Shoulder level-arm raise and force perception*. The underlying components assessed within these task items (defined in the glossary) are balance, bilateral coordination, kinesthetic coordination, kinesthesia, motor planning, muscle tone, proprioception functioning, spatial orientation, unilateral coordination, and vestibular system functioning.

2.7 Conclusion

To conclude the above reported literature, it is clear that development of children takes place throughout their lifespan, already starting in utero, and is influenced by many factors. The body develops from the inside out and from top to bottom, therefore sensory systems inside the body need to be properly developed so that development of movement skills can occur. Effective functioning of internal systems that produce motor movements is also needed. As seen from literature, the sensory system includes the development of the five external senses (touch, taste, smell, hearing, and sight), together with internal senses such as the vestibular and proprioceptive systems. Intact sensory systems are needed in order for effective motor movements to take place.

The proprioceptive system, or otherwise referred to as kinesthesia, forms the basis of knowing where one is in relation to space and the surrounding environment. The proprioceptive system and kinesthetic coordination are important for achieving FMS, consequently enabling the mastery of more complex skills in later childhood. The proprioceptive system needs to be matured in order for sufficient motor coordination to take place. A sufficient proprioceptive system and good kinesthetic coordination is also needed for physical activity, which influences perception therefore influencing academic performance in school. The proprioceptive system is said to be matured and stabilised between the ages of eight and twelve.

The childhood years are important in the overall development of children and consists of the early, middle and later childhood years. Childhood years are classified into movement phases (rudimentary, fundamental and specialised movement phases), which bring about the motor development of children. Motor development of children are subject to many factors contributing to their developmental opportunities, of which the immediate environment being one.

South Africa is a developing and middle-income country, which means that many children live-in poverty. SES in South Africa has a direct influence on the schooling of children, hence the different school quintiles, with different economic support and resources, across the country. South African children in different SES schools have different levels of motor development and academic performance. Children in higher quintile schools perform better academically than children in lower quintile schools, where the opposite have mostly been true for certain motor skills with children in lower quintile schools performing better in some activities, compared to children in higher quintile schools. Learners from low quintile schools were however reported to not maintain these motor skills, as their school environments are not equipped to sustain these skills, negatively affecting their motor development.

The satisfactory development of motor skills produces controlled, skilful and coordinated motor movements. Competence in motor skills is an important foundation for young children, and poor motor coordination can have a negative impact on cognitive development and academic achievement. Poor motor coordination and control may also cause problems in executing daily motor tasks during the early childhood years. The age of six is crucial in the development of children. In South Africa children aged six enter the formal schooling system and it is thus a critical age for their development to be adequate. At this age children already need to have acquired the necessary skills that they will need to perform more complex motor skills (sport skills) and skills need to be refined for successful academic achievement. Gender differences are minimal in early childhood however, differences in some motor skills do occur, such as balancing and object control skills. Hand dominance also needs to be established before children enter grade one, as research state that hand dominance correlates with motor skills of children.

A wide variety of clinical tests exist for the testing of proprioception, but these tests are not always suitable to use in the field and are rather costly. There is currently no field test with norm-based references available in South Africa to evaluate proprioception and kinesthetic coordination. Testing should be as cost effective and accurate as possible, and norms should be based on the population it is being used on. With this in mind, field tasks have been identified using existing literature, and these task items will further aim to assist in providing an accurate measure of children's kinesthetic coordination abilities, especially in the context of the South African population. It is therefore necessary to develop and conduct testing in a range of different quintile schools which make up the South African population as determined from testing in the Manguang, Motheo district.

This literature review served as a detailed background to substantiate the main aim of this research study. It provided information on the following topics: kinesthesia and proprioception, sensory systems during childhood, childhood development and motor development, the environment's influence on development, motor coordination and control, the relation between motor coordination and academic achievement, the development of the six-year-old child and their motor coordination and kinesthetic abilities, along with the gender differences that influence development and the effect of hand dominance on motor development. Lastly, it elaborated on the assessments available to test proprioception and kinesthetic coordination abilities. After conducting the literature review, the researcher finds it necessary to determine the kinesthetic coordination abilities of, especially six-year-old boys and girls, by using field-based tasks with tasks that are easily accessible in the South African setting, and to also to establish kinesthetic coordination norms for these children.

Chapter 3 and 4 will now follow, and report on the results of the study in article format.

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CHAPTER 3: ARTICLE 1

Establishing normal ranges for kinesthetic coordination tasks in six-year-old children in the Mangaung, Motheo District

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Abstract

Background: An intact proprioceptive system and overall kinesthetic coordination is essential for motor control, muscle tone, voluntary movements and academic success. As children are entering the formal school setting at the age of six years, their development at this time is crucial.

Aim: The aim of this study was therefore to establish normal ranges for kinesthetic coordination tasks in six-year-old children.

Setting: This study was conducted in the Mangaung, Motheo district, including 10 schools from different quintiles.

Methods: Participants (N=193) aged six years (mean: 6.46, SD 0.27) were included, of which 97 (50.3%) were boys and 96 (49.7%) were girls. Five field-appropriate kinesthetic coordination tasks were identified and used to establish norms. Normal ranges were established based on the interquintile range (25th and 75th percentiles).

Results: Normal ranges were identified as follow: six – ten successful repetitions for the Angels-in-the-snow task; 22 – 30 seconds for the Rhomberg task; two – three successful repetitions per arm for the finger-to-nose task; two – four successful repetitions for the shoulder-level-arm raise (both arms and preferred arm), one – four successful repetitions for non-preferred arm; and correct identification during the force perception task.

Conclusion and recommendations: Kinesthetic coordination task norms for six-year-olds have been established, enabling practitioners to use these field-appropriate tasks to determine a six-year-old child’s kinesthetic coordination abilities.

Keywords: proprioceptive system, kinesthetic coordination, development, norms, Angels-in-the-snow, rhomberg, finger-to-nose, shoulder-level-arm-raise, force perception, practioners.

3.1 Introduction

Development in general encompasses all aspects of human behaviour (Goodway, Ozmun & Gallahue, 2019) while childhood motor development is exceptionally important as it forms the basis for motor and academic skills used by children later on in their lives. Immature motor coordination resulting from inadequate proprioceptive system functioning can consequently affect cognitive development and academic achievement (Balakrishnan & Rao, 2007). Intact proprioception and overall kinesthetic coordination are thus essential for academic success (Balakrishnan & Rao, 2007) and for effective motor control, muscle tone and voluntary movements (Holst-Wolf, Yeh & Konczak, 2016).

Development takes place physically, psychologically, and socially through interactions between individuals and the environment (Valori, McKenna-Plumley, Bayramova, Zandonella Callegher, Altoë & Farroni, 2020). Children are exposed to changing environments on a daily basis, where they learn how to handle interactions with the environment by collecting information from their senses (Goodway *et al.,* 2019; Tarakci & Tarakci, 2016). Different sensory experiences are crucial to children's development, as sensory information help them to learn how to coordinate large and small muscles (Tahir, Ahmed, Ishaque, Jawaria, Amir & Kamal, 2019). This includes information received from sight, touch, hearing, smell, as well as vestibular and proprioceptive sense (Tarakci & Tarakci, 2016).

Children use their vestibular and proprioceptive system in order to develop a sense of balance and body position, which aids them in movement and positioning themselves in space (Tarakci & Tarakci, 2016; Tahir *et al.,* 2019). Proprioception is defined as the perception of joint and body movement, as well as position of the body or segments of the body in space (Han, Waddington, Adams, Anson & Lui, 2016). It includes awareness of joint position sense, movement sense, force perception and effort, by means of information received from muscle spindles, Golgi-tendon organs and joints receptors (Chu, 2017). This awareness is required for basic motor functions like standing and walking (Woo, Lukacs, de Nooji, Zaytseva, Criddle, Francisco, Jessell, Wilkinson & Patapoutian, 2015). Research argues that proprioception and kinesthesia are synonymous (Han *et al.*, 2016).

Kinesthetic coordination involves integrating body systems to arrange the action of muscles, joints and limbs to acquire strength, speed and resistance in order to perform an intended motor task (Dos-Santos, De Almeida, Manhães-De-Castro, Katzmarzyk, Maia, & Leandro, 2014). Kinesthesia focuses on limb position and movement sense and is a part of the somatosensory system that uses conscious bodily perception distributed throughout the whole body (Françoise, Candau, Alaoui, & Schiphorst, 2017). It is mainly established by the visual, tactile and proprioceptive systems including sensory and motor aspects (Jameel, Yasmeen & Jokerst, 2019).

Research indicates that children below the age of eight make significant errors in movement because of their proprioceptive system not being fully stabilised (Valori et al., 2020). Research argues that sensory systems such as the proprioceptive system is only stabilised by the age of twelve (Peterson, Christou, & Rosengren, 2006). Pienaar, van Reenen and Weber (2016) found that in South Africa a vast majority of six-year-old children don't fully master fundamental movement skills (FMS) that require more complex body coordination and an integration of different body systems, such as skipping and balancing skills. This is a result of especially six-year-old children relying more on other systems like the visual system, instead of fully relying on their proprioceptive system (Pienaar *et al.,* 2016). As six-year-old children in South Africa are entering the formal school setting as grade 1 learners and need to have the necessary developmental building blocks in place for a strong academic foundation, these learners served as the target population for this study.

Proprioception and kinesthesia are complex terms, and although different types of assessments are available to measure proprioception, no set measure of proprioception is advised by researchers (Hillier, Immink, & Thewlis, 2015). There are also very limited available standardised and norm-referenced assessments of proprioception for use in the paediatric field (Chu, 2017). Indirect measures used to assess proprioception in children include the sensory profile, sensory processing measure and sensory integration and praxis tests (Chu, 2017). Other measures to assess proprioception involve extensive laboratory equipment that are not accessible and feasible to most practioners (Chu, 2017).

In the Manguang, Motheo district which is a representation of the South African context movement specialists like Kinderkineticists are not always able to access costly equipment and most parents in low – middle income households are not always able to pay a vast amount of money for their child to be assessed. With the above in mind, this study aimed to establish normal ranges for kinesthetic coordination tasks of six-year-old children in South Africa, by means of feasible field tasks.

3.2 Methods

3.2.1 Study Design

This study was conducted using a quantitative cross-sectional design with a descriptive and analytical approach.

3.2.2 Study population and sampling

Children from a convenience sample of ten schools spanning all five quintiles in the Mangaung, Motheo district were included in this study. The ratio of different quintile schools involved was substantiated by the purpose to collect data which would to an extent be a good representative of the South African population in the Manguang, Motheo district. Schools in South Africa work on a quintile ranking system (one to five). Low-income schools are ranked as quintile one and two, the middle range of schools is classified as quintile three, and affluent schools as quintile four or five (Mestry, 2014:859). It is said that the lower quintile schools are not allowed to charge school fees, whereas quintile four and five schools are allowed to charge fees (Maistry & Africa, 2020:2). The inclusion criteria allowed for inclusion of six-year-olds from the identified schools, but only if principal and parent consent, as well as child assent, were obtained. Children with physical and/or mental disabilities, ear infection or known vestibular problems as well as children absent on the day of testing, as indicated by the teacher, were excluded. 40 consent forms per school were handed out to each of the relevant grade 1 classes.

Consent was received for 222 six-year-old boys and girls. The relatively low response rate of 55.5% could be due to the Covid-19 pandemic and its effect on the schooling system. The schools worked on a rotational attendance schedule, and this resulted in some children not receiving, or not returning consent forms in time. After inclusion and exclusion criteria were applied, 193 participants were included in the study.

3.3 Procedure

After obtaining ethical clearance from the Health Sciences Research Ethics Committee (HSREC) of the University of the Free State (UFS) (UFS-HSD2020/0143/210), the Department of Basic Education (DoBE), the principals of each school, parents of the recruited children as well as child assent, a pilot study was conducted. The pilot study included two participants at each of the identified schools to determine if the testing environment was favourable, if trained interpreters were needed, and if the test form was sufficient to ensure good quality data collection. If all above mentioned aspects were in order during the pilot study, the data was included in the results of the main study.

Data was collected using the kinesthetic coordination tasks as described in detail under measurement instruments. Testing of kinesthetic coordination abilities were done by the researchers and pre-trained field workers who received training on theoretical and practical knowledge of kinesthesia and proprioception testing. 14 field workers were used to collect data however, only three to four field workers were used at each school. Field workers were trained with a theoretical session (in-class) for an hour where the theory of proprioception was discussed as well as the task items were elaborated explained. Field workers also then had an hour practical session where they were teamed up and had to perform the task items and take turns to score the other. All training was done by the main researcher. Where needed the field workers asked the pre-trained interpreter to help them explain the task item, all field workers had assistance by the interpreter. The interpreter also followed the same training as the field workers. The test items were performed in a randomised sequence in order to reduce the possible occurrence of fatigue and to prevent participants being able to communicate the order of the items to their peers. Testing commenced in the morning at a time that was suitable for each school and at a time that did not hinder academic performance and continued for one and a half to two hours, in order to test the whole participant group at the relevant school.

3.4 Measurement Instruments

Five task items were identified and was used to measure the proprioceptive and/or kinesthetic coordination abilities of the participants involved (Cheatum & Hammond, 2000; Chu, 2017). These tasks (such as the Angels-in-the-snow, Rhomberg and Finger-to-nose tests) are generally used by other researchers to determine proprioceptive abilities in terms of motor control, motor coordination and kinesthesia (Swaine, Desrosiers, Bourbonnals & Larochelle, 2005; Moran, Carvalho, Prado & Prado, 2005). Although these tasks have no specific reported validity or reliability values (Cheatum & Hammond, 2000; Chu, 2017), they do have set execution instructions which were used for this study. Currently no cut-off values or norms for South African children are available for the five identified tasks.

The test form for each participant included a sequence number; participant's gender, height, weight, birth date and chronological age, as well as a table to record raw scores. Data was recorded on the test form as a "yes" if the participant was able or as a "no" if the participant was not able to do the movements as required. The quality of the movements was observed and recorded for each task item. Formal administration of the tasks took approximately 10-15 minutes per participant but did depend on the degree of difficulty experienced by the participant. Participants were tested individually.

Task items and guidelines for the execution of the items included:

1. **Angels-in-the-snow Task:**

Researchers have used the Angels-in-the-snow test in order to evaluate children's coordination (Mutti, Martin, Sterling & Spalding, 2017). Before commencement of this task, the researchers taped a solid straight line on a yoga mat for the participant to lie on, with the line being in the middle of their bodies. Researchers then told the participant that they will point to limb/s that need to be moved, that they should not lift it up, and that they need to return it to normal relaxed position. Participants needed to perform a series of eleven consecutive movements as derived from Cheatum and Hammond (2000) with a maximum repetition of four per movement. The quality of the movement recorded included the occurrence of associated movements; moving other parts of the body together with limbs;

uncoordinated movements; movement hesitation; looking at limbs; and touching or banging limbs against the floor to "wake them up". Results were scored from a 0-4 (0: if they could not perform the movement/s, 1: if they could only do 1 movement; 2: if they could perform the movement only twice, 3: if they could perform the movement/s three times and 4: if they could perform the movement/s to the full amount). Quality of the movement was scored as a yes or no on the test form.

2. Rhomberg Task:

This test evaluated balance in a standing position. Participants stood with feet together; arms relaxed at their side. The researcher asked the participant to stand up straight and keep balance with their eyes closed. Data was recorded as the number of seconds the participant was able to stand in the specified position. A maximum of 30 seconds could be recorded. The quality of movement referred to weaving, swaying or moving/lifting limbs (Cheatum & Hammond, 2000).

3. Finger-to-Nose Task:

Different versions of the finger-to-nose task exist (Swaine et al., 2005; Sayar & Űnűbol, 2017; Cheatum and Hammond, 2000). For the purpose of this study the finger-to-nose task was done by extending both arms next to the body to shoulder level and then with each index finger alternating touching the tip of the nose and returning the arm to original position, while eyes are open and then closed. The required number of successful repetitions performed by the participant was three per side, which equals a maximum amount of six. The quality of the movement observed provided specific information regarding unusually fast or slow movements, if the hand moved consistently to the right, left, top or bottom, and if the participant missed the nose by 1 to 2,5cm.

4. Shoulder-Level Arm-Raise Test:

This item was used as set out by Cheatum and Hammond (2000) and assessed movement of a limb around a joint and in space. Participants stood with eyes closed and then raised arm/s to the front in the following ways: raising preferred arm to shoulder level, then non-preferred arm and then both arms. Data was recorded as a number of correct repetitions performed up to a maximum of four. The quality of the movements was recorded, observing wrist drop, arm/s level and body position, or correct body posture.

5. **Force perception:**

This task item, as set out and explained by Chu (2017) was used to assess force sense. The participants stood with arms stretched out in-front of them with eyes closed. A light weighted object (500 g) was placed in one hand and a heavier weighted object (1kg) was placed in the other hand. Ankle/arm weights (same length, different sizes) were used for this task item. The participant needed to tell the researcher which hand had the heavier weight in. This task was only performed once. The quality of the movement was recorded observing swaying or movement of the body.

3.5 Ethical Considerations

This study was approved by the HSREC of the UFS (UFS-HSD2020/0143/210 as well as the DoBE. All aspects of data collection were conducted according to the ethical guidelines and principles of the South African Guidelines for Good Clinical Practice and the Medical Research Council (MRC) Ethical Guidelines for Research. Permission. Consent from the parents/guardians and assent from the participants were obtained prior to commencement of the data collection. A participant number, instead of their name was used to ensure privacy and all data was handled confidentially and according to the above-mentioned guidelines. Measurement errors were reduced as far as possible by ensuring adequate training of the field workers and the interpreter, as well as proper demonstration and explanation of the task-items to participants. Optimal testing time (length and time of day) was allocated when data was collected, and handling of raw data was quality controlled.

3. 6 Data Analysis

Collected data was entered into a Microsoft Excel spreadsheet, converted into a SAS data set, and analysed by a Biostatistician using the SAS software (SAS Institute Inc, 2017).

The statistical analysis of the data was largely descriptive. Quantitative variables were summarized using descriptive statistics (mean, SD, minimum, P25, median, P75, maximum). For quantitative kinesthetic measurements the following additional percentiles were calculated to estimate normal ranges for each of the variables: P5, P10, P90 and P95. Categorical variables were summarized using frequencies and percentages for variables indicating quality of movement or correctness in carrying out a test. Normal ranges for six-year-old children were established based on the interquintile range (25^{th} and 75^{th} percentiles) of each variable, representing the middle 50% of data.

3.7 Results

N=193 participants with an average age of 6.46 years (SD, 0.27), of which 97 were boys (50.26%) and 96 were girls (49.74%) participated in the study. The participant group had an average weight of 21.9kg (SD, 8.72) and an average height of 117.17cm (SD, 7.44), with 20 (10.36%) being left-handed and 173 (89.64%) being right-handed.

Table 3.1 presents descriptive statistics and normal ranges for kinesthetic coordination tasks as established from 193 six-year-old participants in the Mangaung, Motheo district. The interquintile range represents the execution of kinesthetic coordination tasks between the 25^{th} and 75^{th} percentile. This middle 50% of data was defined the expected norm for children of this age.

Table 3. 1: Descriptive statistics and normal ranges for kinesthetic coordination tasks (N=193), excluding force perception

	Angels-in-the-snow	**Rhomberg**	**Finger-to-nose**		**Shoulder-level-arm raise**		
			Left	Right	PA	NA	B
Mean	7,66	25,52	2.34	2,48	2,9	2,65	2,88
SD	2,87	7,63	1,07	0,96	1,57	1,64	1,57
Min	0	0	0	0	0	0	0
P5	2	8	0	0	0	0	0
P10	4	12	0	1	0	0	0
P25	6	22	2	2	2	1	2
P50	8	30	3	3	4	4	4
P75	10	30	3	3	4	4	4
P90	11	30	3	3	4	4	4
Max	11	30	3	3	4	4	4

Source: No source
B: both; Min: minimum; Max: maximum; NA: non-preferred arm; P: percentile; PA: preferred arm; SD: Standard Deviation.

For Angels-in-the-snow, the normal range is six to ten successful executions of the eleven movements for this task. Less than six successful executions are considered below the norm and more than ten above the norm. The normal range established for the Rhomberg test is set at 22 – 30 seconds (secs). Two to three repetitions (reps) for the left and right hand are identified as being the normal range for the finger-to-nose task. The shoulder-level-arm raise task makes use of the preferred arm, non-preferred arm and both arms. For the preferred arm the normal range is set as two to four successful reps. With regards to the non-preferred arm the normal range is one to four successful reps. For the last movement (both arms), the normal range is considered as two to four successful reps.

Table 3.2 summarizes the number of successful repetitions of each of the eleven movements of the Angels-in-the-snow task. The participants found it relatively easy to execute movement tasks one to seven, while the number of successful executions visibly decreased from tasks eight to eleven. Only 60% of the participants were able to execute four successful movements with the right arm and the right leg simultaneously (movement 8), while 59% were successful in moving the left arm and the left leg simultaneously (movement 9). This percentage decreases even further for movement task ten and eleven, with only 36% successfully moving the right arm and left leg simultaneously for four repetitions and only 28% being able to do four successful movements with the left arm and right leg simultaneously.

Table 3. 2: Qualitative statistics for the eleven Angels-in-the-snow movements

Movement	**Statistic**	**Successful repetitions**				
		0	1	2	3	4
1	Frequency	15	7	14	26	131
	%	7.77	3.63	7.25	13.47	67.88
2	Frequency	10	3	11	9	160
	%	5.18	1.55	5.70	4.66	82.90
3	Frequency	6	2	0	6	179
	%	3.11	1.04	0.00	3.11	92.75
4	Frequency	12	6	3	18	154
	%	6.22	3.11	1.55	9.33	79.79
5	Frequency	12	8	4	11	158
	%	6.22	4.15	2.07	5.70	81.87
6	Frequency	13	2	3	8	167
	%	6.74	1.04	1.55	4.15	86.53
7	Frequency	13	2	2	2	174
	%	6.74	1.04	1.04	1.04	90.16
8	Frequency	28	6	13	30	116
	%	14.51	3.11	6.74	15.54	60.10
9	Frequency	27	14	12	26	114
	%	13.99	7.25	6.22	13.47	59.07
10	Frequency	55	19	19	30	70
	%	28.50	9.84	9.84	15.54	36.27
11	Frequency	71	22	20	25	55
	%	36.79	11.40	10.36	12.95	28.50

Source: No source
%: Percentage; *Please refer to measurement instruments for detailed information on qualitative aspects.

Table 3.3 focuses on the quality of the movement of the Angels-in-the-snow task. Most participants did not struggle with uncoordinated movements or with touching or banging their limb/s. More, than 60% of participants, however, performed the movements with hesitation, while almost half of the participants did look at their limb/s.

Table 3. 3: Quality of movements for Angels-in-the-snow

Associated movements		Uncoordinated		Hesitation		Looks at limb/s		Touches/bangs limb/s	
Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
20	10.36	65	33.68	116	60.10	84	43.52	37	19.17

Source: No source
Freq: frequency; %: percentage; *Please refer to measurement instruments for detailed information on qualitative aspects.

Table 3.4 indicates that almost half the participants did lose their balance, moved their feet and lifted their arm/s while executing the Rhomberg balance task. The majority of participants (70.47%) did not weave back and forth during execution of the task.

Table 3. 4: Quality of movement for Rhomberg task

Balance loss		Weaving		Moves feet		Lifts arms	
Freq	%	Freq	%	Freq	%	Freq	%
94	48.70	57	29.53	78	40.41	84	43.52

Source: No source
Freq: frequency; %: percentage; *Please refer to measurement instruments for detailed information on qualitative aspects.

Table 3.5 suggests that participants did not struggle with the finger-to-nose movement task, except for missing the nose (30.57%) and missing the tip of the nose by more than one cm (41.45%).

Table 3. 5: Quality of movement for finger-to-nose task

Fast/ Slow		**Right/Left**		**Top/Bottom**		**Misses nose**		**Misses tip**		**Random/Unsteady**	
Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
20	10.36	40	20.73	45	23.32	59	30.57	80	41.45	30	15.54

Source: No source
Freq: frequency; %: percentage; *Please refer to measurement instruments for detailed information on qualitative aspects.

In Table 3.6 it is evident that most of participants did not have difficulty lifting the preferred arm, non-preferred arm and both arms to shoulder level. Participants did, however, have difficulty lifting arms to the same level during each repetition, as half of them (50.26%) could not successfully do this.

Table 3. 6: Quality of movement for shoulder-level-arm-raise task

Wrist drop		**Not same level**		**Incorrect position**		**Sways/Bends**	
Freq	%	Freq	%	Freq	%	Freq	%
10	5.18	97	50.26	39	20.21	47	24.35

Source: No source
Freq: frequency; %: percentage; *Please refer to measurement instruments for detailed information on qualitative aspects.

Table 3.7 summarizes the force perception task. Most participants could perform this movement task correctly and did not have a lot of difficulty identifying the heavier object. Furthermore, more than 90% of participants did not sway or bend their body in any direction.

Table 3. 7: Descriptive and qualitative data results for the force perception task

Correct hand identified		**Sways/Moves body**	
Freq	%	Freq	%
161	83.42	17	8.81

Source: No source
Freq: frequency; %: percentage; *Please refer to measurement instruments for detailed information on qualitative aspects.

3.8 Discussion

This study aimed to establish normal ranges for kinesthetic coordination tasks in six-year-olds using five kinesthetic coordination task items.

The results of this study show that six-year-old children should be able to do at least six out of the eleven movements of the Angels-in-the-snow items for them to fall into the normal range. A study done on the bilateral coordination ability of children between the ages of five and fifteen years, reported that bilateral coordination ability improves with age (Karambe, Dhote, Palekar, 2017). The results of the current study also indicate that when six-year-old children execute the Angels-in-the-snow tasks, they especially struggle with movements that rely more on body coordination, using their limbs bilaterally and contra-laterally, as well as movements that require greater muscle control. Research on three- to twelve-year-old children indicated that motor skills which require more body coordination will require additional movement coordination abilities (Gandotra, Kótyuk, Sattar, Bizonics, Csaba, Cserényi & Cserjesi, 2021). In agreement with our findings, Cheatum & Hammond (2000) stated that children aged five to nine years, struggled with contralateral movements. Underpinning results from the current study, these researchers also state that movements develop in sequences, first with unilateral movements that require the use of only one limb to move at a time, then homolateral which requires movement of limbs on the same side of the body (e.g., right arm and right leg) (Cheatum & Hammond, 2000). This is followed by bilateral movement coordination, referring to the ability to coordinate each side of the body in a controlled manner (e.g., left arm and right arm) (Gazbare, Deshmukh, Palekar,Varghese, Abraham, Singh & Desai, 2020), and finally contralateral movements which refer to using the opposite sides of the body (Kakebeeke, Messerli-Bu, Meyer, Zysset, Stübl *et al.,* 2017) e.g., the right leg and left arm. In contrast to our findings Cheatum & Hammond (2000) reported specifically on the Angels-in-the-snow task, and stated that children struggle with unilateral movements, which was not the case in our study. Coordination abilities are also utilised during the execution of FMS. Findings of a South African study state that children aged six do not yet fully master FMS which are more complex of nature, and which require greater body coordination (Pienaar *et al.,* 2016). Researchers therefore indicate that it is necessary to implement body/motor coordination programmes for children aged six and above in order to establish motor coordination skills needed in adulthood (Lima, Bugge, Pfeiffer & Andersen, 2017:56,58).

For the Rhomberg task, it can be expected of six-year-old children to keep static balance with eyes closed for at least 22 – 30 seconds. The results of this study also highlighted that six-year-old participants have relatively stable stationary balance skill, but almost half of the participants could qualitatively not perform the Rhomberg test without loss of balance. A study done by Jiang, Jiao, Wu, Ji, & Liu et al. (2018) evaluated the static and dynamic balance on three to six-year-old children and reported balance skills to improve with age. Their results indicated that balance is significantly better in six-year-olds (Jiang *et al.,* 2018), which is synonymous with our findings of 22 – 30 seconds of static balance for children aged six. The study of Jiang *et al.* (2018) also stated that balance and proprioception are crucial to the development of children, and that the ages of three to six is critical in child development. These aged children therefore need ample opportunities (at school and at home by means of play) to successfully establish their balance and proprioceptive abilities (Jiang *et al.,* 2018).

The finger-to-nose task uses both arms and is a good indicator to establish if six-year-old children are able to coordinate their body movements, mainly referring to coordination of the two arms. From results of the current study, children aged six should be able to perform this task with two to three successful repetitions per arm. Swaine and co-workers (2005) stated that during the execution of the different finger-to-nose task versions, touching the tip of the nose is the most difficult, which was also observed in the current study. The finger-to-nose task used in this study observed the following movements qualitatively: are movements performed too fast or slow, too random or unsteady, did participants move their hand too far to the right or left or to the top or bottom, did participants miss their nose. Results reciprocated Swaine and co-workers' (2005) study, which stated that participants did more frequently miss the tip of their nose, compared to any of the other qualitative criteria. Missing the tip of the nose can possibly indicate proprioceptive system functioning problems (Bo, 2019). No current studies could be found focussing on specifically spatial awareness and kinesthetic coordination abilities of the six-year-old child and results could therefore not be compared to exactly similar studies.

The shoulder-level-arm raise task makes use of the preferred arm, non-preferred arm and both arms. Adequate kinesthetic coordination requires of six-year-olds to be able to perform this task with their preferred arm for two – four repetitions, their non-preferred for one – four repetitions, and both arms for two – four repetitions. The only difficulties experienced by participants in this task was that they could not lift their arm to the same level each time, which could indicate muscle tone and muscle control difficulties. Clinical assessments for muscle tone and muscle control in children aged three to eleven indicated that activities which activate only certain muscle groups, such as performing the shoulder-level-arm raise task and activating mainly the shoulder girdle muscles, should be further researched (Goo, Tucker & Johnstone, 2018). Goo *et al.* (2018) is also of the opinion that such activities can be used as an assessment of muscle tone in specifically six-year-old children. The shoulder-level-arm-raise task can consequently be more feasible compared to costly apparatus in determining muscle tone and muscle control in children.

The last task was force perception, kinesthetic coordination ability for the six-year-old child is indicated by correctly identifying in which hand the heavier object has been placed. Participants performed well in the force perception task and were able to successfully execute the task. To our knowledge, no studies related to specifically force perception in the six-year-old child and force perception as a kinesthetic coordination ability have been conducted, and therefore no comparable results can be discussed.

3.9 Conclusion

Normal ranges for the five kinesthetic coordination tasks (Angels-in-the-snow, Rhomberg, finger-to-nose, shoulder level-arm raise and force perception) for six-year-old children have been established and can be used to screen for kinesthetic coordination backlogs in children of this age.

3.10 Limitations and Recommendations

The main limitation of the study was Covid-19. The impact of national regulations due to the pandemic resulted in learners attending school on a rotation basis, which negatively affected the return of consent forms on the day of testing, due to learner absence. Another limitation was a language barrier at some of the school and therefore the interpreter was used were needed.

We recommend that movement specialists like Kinderkineticists use the normal ranges established here for the five identified task items in order to identify proprioception difficulties in six-year-old children. Use of the shoulder-level-arm-raise task is also recommended to movement specialists like Kinderkineticists in order to evaluate muscle tone and control in children as it is more cost effective than clinical apparatus. Results will aid practitioners to recommend movement programmes for the correction of proprioception difficulties. Further research on this topic using a bigger sample size, with children of different ages and in other provinces of South Africa is recommended. It is also recommended that the tasks identified in this study are proven to be reliable and valid, thus reliability and validity of the five identified tasks should be established within future research.

3.11 Acknowledgements

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3.12 References

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CHAPTER 4: ARTICLE 2

Kinesthetic coordination abilities in six-year-old children: School quintile, gender, and dominance differences

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Abstract

Background: Several factors can influence the kinesthetic coordination abilities of six-year-old children

Aim: To establish if kinesthetic coordination differences exist in six-year-old children regarding school quintiles, gender and hand dominance.

Setting: Ten schools from different quintiles in the Mangaung, Motheo district were used. 193 six-year-old children were included, 97 (50.3%) were boys and 96 (49.7%) were girls.

Methods: Five kinesthetic coordination task were used and differences between aforementioned variables determined.

Results: Kinesthetic coordination differences between school quintiles was not significant. Right-hand dominant participants performed significantly better in the finger-to-nose task. Boys outperformed girls in the should-level-arm-raise (p=0.0288), girls outperformed boys in the force perception task (p=0.0322).

Conclusion and recommendations: Kinesthetic coordination abilities are to some extent influenced by school quintile status, gender and hand dominance. Focus should be on children in high SES's balance, force perception of boys and left-hand dominant children's coordination abilities.

Keywords: kinesthetic coordination, gender, socio-economic status, hand dominance.

4.1 Introduction

Proprioception in the initial stage of motor development (two to six years) is of the greatest importance (Úbeda-Pastor, Llana-Belloch & García-Massó, 2018), and has been established as a central aspect for movement control and motor learning. Both movement control and motor learning are essential for a child's motor development (Rossi, Bastian & Therrien, 2021).

Motor development is exceptionally important as it relates to every aspect of a child's development (Anderson, 2018). Motor skills comprise of fine-and gross motor skills and is influenced by postural control, muscle tone, body alignment, and motor coordination (Park, 2015). Úbeda-Pastor and co-workers (2018) reported that by the age of seven children have greater control in their motor development and stated that at this age proprioception has a great effect on their postural and balancing skills. An intact proprioceptive system is important for movement as proprioceptive information allows children to make movement corrections as they move (Magill & Anderson, 2017). Proprioception can be seen as position sense and movement of one's own body parts, as well as tension sense or force perception, together with the effort exerted by relevant muscles (Bornstein, Konstantin, Alessandro, Tresch & Zelzer, 2021). Proprioception and kinesthesia are said to be synonymous (Han, Waddington, Adams, Anson & Lui, 2016). Kinesthesia is defined as the awareness of limb position and movements sense and relies on joint receptors to detect the awareness of kinesthetic sense (Proske, 2006; Siegel & Sapru, 2011). Kinesthetic sense also relates to the sense of limb position and movement, and an individual is made aware of this sense when for example, one tries to touch the tip of the nose with the index finger, while eyes are closed (Proske & Gandevia, 2012). Intact kinesthesia is necessary for effective motor performance and postural control (Li, Su, Fu & Pickett, 2015), as kinesthetic sense is derived from the motor commands that generate a motor movement (Proske, 2006).

Motor development and development of the proprioceptive system is important and can be influenced by many factors, some of which are intrinsic of nature, whereas others are extrinsic (Goodway, Ozmun & Gallahue, 2019). Intrinsic factors include amongst others gender, genetics, dominance (hand), direction of development, reciprocal interweaving between fine-and gross motor in addition to muscle and sensory system function, readiness to execute a task, biology of the individual, as well as environment conditions to bring about a motor skill (Goodway e*t al.,* 2019). Lastly mentioned include skills that are more resistant to environmental factors (phylogeny) like walking and skills that are more influenceable by the environment (ontogeny) like riding a bicycle (Goodway *et al.,* 2019). Whereas socio-economic status (SES), school environment, bonding between parent and infant, fundamental movement skill (FMS) stimulation opportunities and lack of opportunities to develop skills (Goodway e*t al.,* 2019), are some concepts that make up extrinsic factors (Goodway *et al.,* 2019). Factors of importance for this study include gender, hand dominance, and SES.

Children are unique individuals, and girls and boys grow and mature differently and develop within their own unique timelines (Goodway *et al.,* 2019). Gender differences as an intrinsic factor is related to motor development of children (Thomas & French, 2000). Gender differences during motor skill acquisition in infancy are said to be few and inconsistent and minimal differences in height and weight are seen, however as children grow into adulthood, more and more gender differences are observed specifically in regard to gross motor skills (Flatters, Hill, Williams, Barber & Mon-Williams, 2014; Goodway *et al.,* 2019). In relation to early childhood years where children mainly use FMS (consisting of among others coordination skills, balance & locomotor skills), it is reported that boys do better in object control skills such as kicking and catching, while girls perform better in locomotion skills such as skipping (Bolger, Bolger, O'Neill, Coughlan, O'Brien, Lacey & Burns, 2018). In a study done by Kokŝtejn, Musálek and Tufano (2017) using the Movement Assessment Battery (MABC) on 325 children aged three to eight years in the Czech Republic, findings stated that manual dexterity and balance between boys and girls aged six showed no gender differences. In their study, boys did, however, outperform girls in aiming and catching (Kokŝtejn et al., 2017). A possible explanation for the differences in aiming and catching can stem from participation in activities which are gender stereotyped. According to this stereotype boys engage more in coordination skills that require object manipulation, like playing with a ball, and therefore have more opportunities to develop and practice coordination skills compared to girls (Venetsanou & Kambas, 2016; Bardid, Huyben, Lenoir, Seghers, Martelaer et al., 2016).

Hand dominance is classified as an intrinsic factor but can be influenced by external influences. Hand dominance is a fundamental feature after birth (external factor) and therefore a fundamental feature before birth (internal factor) (Hepper, Wells & Lynch, 2005). Pre-natal motor behaviour (thumb sucking) is directly linked to hand dominance post-natality, with results being stronger for right-handedness than for left-handedness (Hepper *et al.,* 2005). Hand dominance in infancy directly correlates with motor skills when children get older, including skills such as playing with a ball (object manipulation) (Hinojosa, Sheu, Michel, 2003). Children three to five years old typically demonstrate weak and inconsistent hand dominance tendencies (Sharoun & Bryden, 2014). As children mature (seven to ten years old) hand dominance becomes established (Sharoun & Bryden, 2014), while the maturation and establishment of hand dominance means that movement skills can become more refined (Sharoun & Bryden, 2014). The maturation, establishment and refinement of hand dominance and movement skills reflect children's cognitive motor development (Sharoun & Bryden, 2014). When motor skills are taught to children at a young age (four – six years) it needs to be done using their dominant hand, otherwise their performance might reflect poorer movement skill level than their actual abilities (Parish, Dwelly, Baghurst & Lirgg, 2013). Hand dominance or hand preference is needed to prevent unfavourable development, especially in early childhood (children up to the age of six) (Kastner-Koller, Deimann & Bruckner, 2007).

Motor development, coordination and proprioception is influenced by the growing, maturing and developing of children within their environment (Malina, Bouchard & Bar-Or, 2004). Environmental factors such as the environment in which the child grows up in, including play opportunities, are directly linked to SES (Malina *et al.,* 2004). SES is most commonly viewed and measured in accordance with education, income and occupation; however health, home ownership or neighbourhood disadvantage can also be used to classify SES (Cockerham, Dingwall, Quah, 2014). The South African schooling system ranks schools according to different quintiles, where lower quintile schools (one to three) are classified as schools from "poorer" environments and higher quintile schools (four and five) as schools from "richer" environments (Maistry & Africa, 2020). Children in lower quintile schools are said to perform poorer in academic and motor proficiency domains (Smith, 2011; Ogbonnaya & Awuah, 2019). Children living in high and middle SES environments significantly outperformed low

SES counterparts with regard to total-, fine- and gross motor skills (Morley, Till, Ogilvie & Turner, 2015). This finding was also substantiated by a study done in England on 369 children between the ages of four and seven using the BOT-2 (Morley *et al.,* 2015). In South Africa, de Waal and Pienaar (2020) also bared witness to the fact that children from low SES have decreased motor proficiency levels, in a study conducted on 381 grade one to seven learners from a variety of different quintile schools (one to five). Research therefore affirms that children living in middle and high SES environments have better motor proficiency skills than children living in low SES environments (Morely *et al.,* 2015; de Waal & Pienaar, 2020).

Taking the above literature into consideration it is evident that intact proprioception, kinesthesia and kinesthetic coordination is of high importance to the development of children. School quintile status, gender and hand dominance differences with regard to kinesthetic coordination abilities have not yet been researched in South Africa. The main focus of this study is therefore to observe differences in kinesthetic coordination abilities of six-year-old children from different school quintiles, of different gender and with different hand dominance, in Mangaung Motheo District, South Africa.

4.2 Methods

4.2.1 Study Design

This study used a quantitative cross-sectional design with a descriptive and analytical approach.

4.2.2 Study population and sampling

Six-year-old children were included in the study. Ten schools from different quintiles (one to five) in the Mangaung, Motheo district were recruited using convenience sampling on recommendation of the biostatistician. One quintile one, one quintile two, four quintile three, three quintile four and one quintile five schools participated in the study. The ratio of different quintile schools involved was substantiated by the purpose to collect data which would to an extent be a good representative of the South African population especially in the Manguang, Motheo district. Forty consent forms per school were handed out to each of the relevant six-year-olds. Although there might have not been 40 six-year-olds, 40 was used as an equal number on recommendation from the biostatistician.

Consent was received for 222 six-year-old boys and girls from low to high SES schools in the Mangaung, Motheo District. After inclusion and exclusion criteria were applied the sample size included 193 participants with an average age of 6.46 years (SD, 0.27), of which 97 were boys (50.26%) and 96 were girls (49.74%). Twenty (10.36%) participants were left-handed and 173 (89.64%) were right-handed. The inclusion criteria allowed for inclusion of six-year-old children from the identified schools, and only if principal and parent consent, as well as child assent, were obtained. Children with indicated physical and/or mental disabilities, ear infection or known vestibular problems as indicated by the teacher, incomplete assent and/or consent forms, as well as absence on the day of testing, were excluded.

4.2.3 Procedure

After obtaining ethical clearance from the Health Sciences Research Ethics Committee (HSREC) of the University of the Free State (UFS) (UFS-HSD2020/0143/210), the Department of Basic Education (DoBE), the principals of each school, informed consent from the parents of the recruited children as well as child assent, a pilot study was conducted. The pilot study included two participants at each of the identified schools to determine if the testing environment was favourable, if trained interpreters were needed, and if the test form was sufficient to ensure good quality data collection. If all above mentioned aspects were in order during the pilot study, the data was included in the results of the main study.

Data was collected using the kinesthetic coordination tasks as described in detail under measurement instruments. Testing of kinesthetic coordination abilities were done by the researchers and pre-trained field workers who received training on theoretical and practical knowledge of kinesthesia and proprioception testing. 14 field workers were used to collect data however, only three to four field workers were used at each school. Field workers were trained with a theoretical session (in-class) for an hour where the theory of proprioception was discussed as well as the task items were elaborated explained. Field workers also then had an hour practical session where they were teamed up and had to perform the task items and take turns to score the other. All training was done by the main researcher. Where needed the field workers were assisted by a pre-trained interpreter. The interpreter also followed the same training as the field workers. The test items were performed in a randomised sequence in order to reduce the possible occurrence of fatigue and to prevent participants being able to communicate the order of the items to their peers. Testing commenced in the morning at a time that was suitable for each school and at a time that did not hinder academic performance and continued for one and a half to two hours, in order to test the whole participant group at the relevant school.

4.2.4 Ethical Considerations

This study was approved by the (HSREC) of the UFS (UFS-HSD2020/0143/210) as well as the DoBE. All aspects of data collection were conducted according to the ethical guidelines and principles of the South African Guidelines for Good Clinical Practice and the Medical Research Council (MRC) Ethical Guidelines for Research. Consent from the parents/guardians and assent from the participants were obtained prior to commencement of the data collection. A participant number, instead of their name was used to ensure privacy and all data was handled confidentially and according to the above-mentioned guidelines. Measurement errors were reduced as far as possible by ensuring adequate training of the field workers and the interpreter, as well as proper demonstration and explanation of the task-items to participants. Optimal testing time (length and time of day) was allocated when data was collected, and handling of raw data was quality controlled by the main researcher and kept safe in a secure location and then in a password protected Excel spreadsheet.

4.2.5 Measurement Instruments

Five task items were identified and was used to measure the proprioceptive and/or kinesthetic coordination abilities of the participants involved (Cheatum & Hammond, 2000; Chu, 2017). These tasks (such as the Angels-in-the-snow, Rhomberg and Finger-to-nose tests) are generally used by other researchers to determine proprioceptive abilities in terms of motor control, motor coordination and kinesthesia (Swaine, Desrosiers, Bourbonnals & Larochelle, 2005; Moran, Carvalho, Prado & Prado, 2005). Although these tasks have no specific reported validity or reliability values (Cheatum & Hammond, 2000; Chu, 2017), they do have set execution instructions which were used for this study. Currently no cut-off values or norms for South African children are available for the five identified tasks.

The test form for each participant included a sequence number; participant's gender, height, weight, birth date and chronological age as well as a table to record raw scores. Data was recorded as a "yes" if the participant was able or as a "no" if the participant was not able to do the movements as required. The quality of the movements was observed and recorded for each task item. Formal administration of the tasks took approximately 10-15 minutes per participant but depended on the degree of difficulty experienced by the participant. Hand dominance was determined by indicating the preferred hand that participants used to fill in their assent form, on their test form.

Task items and guidelines for the execution of the items included:

1. **Angels-in-the-snow Task:**

Researchers have used the Angels-in-the-snow test in order to evaluate children's coordination (Mutti, Martin, Sterling & Spalding, 2017). Before commencement of this task, the researchers taped a solid straight line on a yoga mat for the participant to lie on, with the line being in the middle of their bodies. Researchers then told the participant that they will point to limb/s that need to be moved, and that they should not lift it up and they need to return it to normal relaxed position. Participants needed to perform a series of eleven consecutive movements as derived from Cheatum and Hammond (2000) with a maximum repetition of four per movement. The quality of the movement recorded included the occurrence of associated movements; moving other parts of the body together with limbs; uncoordinated movements; movement hesitation; looking at limbs; and touching or banging limbs against the floor to "wake them up".

2. **Rhomberg Task:**

This test evaluated balance in a standing position. Participants stood heel-toe, toes facing forward; arms relaxed at their side. The examiner asked the participant to stand up straight and keep balance with their eyes closed. Data was recorded as the number of seconds the participant was able to stand in the specified position. A maximum of 30 seconds could be recorded. The quality of movement referred to weaving, swaying or moving/lifting limbs (Cheatum & Hamoond, 2000).

3. **Finger-to-nose Task:**

Different versions of the finger-to-nose task exist (Swaine et al., 2005; Sayar & Űnűbol, 2017). For the purpose of this study the finger-to-nose task was done by extending both arms next to the body to shoulder level and then with each index finger alternating touching the tip of the nose and returning the arm to original position, while eyes are closed. The required number of successful repetitions performed by the participant was three per side, which equals a maximum amount of six. The quality of the movement observed provided specific information regarding unusually fast or slow movements, if the hand moved consistently to the right, left, top or bottom, and if the participant missed the nose by one to two and a half cm.

4. **Shoulder-Level Arm-Raise Test:**

This item was used as set out by Cheatum and Hammond (2000) and assessed movement of a limb around a joint and in space. Participants stood with eyes closed and then raised arm/s to the front in the following ways: raising preferred arm to shoulder level, then non-preferred arm and then both arms. Data was recorded as a number of correct repetitions performed up to a maximum of four. The quality of the movements was recorded, observing wrist drop, arm/s level and body position, or correct body posture.

5. **Force perception**

This task item, as set out and explained by Chu (2017) was used to assess force sense. The participants stood with arms stretched out in-front of them with eyes closed. A light weighted object (500 gram (g)) was placed in one hand and a heavier weighted object (one kilogram (kg)) was placed in the other hand. The participant needed to tell the researcher which hand had the heavier weight in. This task was only performed once. The quality of the movement was recorded observing swaying or movement of the body.

4.2.6 Data Analysis

Collected data was entered into a Microsoft Excel spreadsheet, converted into a SAS data set, and analysed by a Biostatistician using the SAS software (SAS Institute Inc, 2017).

4.2.6.1 Descriptive Statistics

Quantitative variables were summarized using descriptive statistics (mean, SD, minimum, median, maximum), overall, for the whole sample, by SES, by gender, and by preferred arm (PA). This was done using the norms established in article one (Chapter three).

4.2.6.2 Comparison of school quintiles, genders, preferred arm (hand dominance)

Quantitative data were compared between genders, and with regard to hand dominance using the nonparametric Wilcoxon Two-sample test. The school quintiles were compared with respect to quantitative data using the Cochran-Mantel-Haenszel (correlation) chi-square test; and the binary variable Force perception was analysed compared using Fisher's exact test. In each case the associated P-value is reported. Cohen's *d* effect sizes were used to indicate practical significance for preferred arm and gender differences in the Angles-in-the-Snow, Rhomberg and finger-to-nose tasks, and only for gender differences in the shoulder-level-arm-raise task. A value of 0.2 indicated a small practical effect, 0.5 a medium practical effect, and 0.8 a large practical effect (Salkind, 2010).

4.3 Results

Table 4.1 summarizes the Angels-in-the-snow task. Results show that participants from different quintile schools (one to five) performed similar to each other, with the exception of quintile three schools. They had a lower mean value (6.37) compared to the other quintile schools' mean values, which are all higher than 8.00. The quintile three schools also had a higher number of participants classified as below the norm (six to ten successful repetitions for the Angels-in-the-snow task), however, differences between school quintiles were not statistically or practically significant. The quintile five school had the highest percentage of participants that fell into the norm (90.9%) or above the norm (9.1%) for this task.

Girls performed slightly better (mean = 7.76) than boys (mean = 7.57) in the Angels-in-the-snow task, but the difference was again not statistically significant. Similarly, participants with a left-hand dominance, performed slightly better (with 65% of children falling within the norm) than right-hand dominant participants (61.85% fell into the norm) with differences not being statistically significant or having a practical effect.

Table 4. 1: Angels-in-the-Snow

	Group					**Below**		**Within**		**Above**	
		Mean	**SD**	**P-value**	***d*-value**	**N**	**%**	**n**	**%**	**n**	**%**
School Quintile	1	8.50	2.53	0.9693		3	9.38	22	68.75	7	21.88
	2	8.50	2.07			1	12.50	6	75.00	1	12.50
	3	6.37	3.42			25	39.68	27	42.86	11	17.46
	4	8.10	2.38			11	13.92	55	69.62	13	16.46
	5	8.91	1.58			0	0.00	10	90.91	1	9.09
Gender	Girls	7.76	3.02	0.3792	0.0672	19	19.79	59	61.46	18	18.75
	Boys	7.57	2.73			21	21.65	61	62.89	15	15.46
Preferred Arm	Left	7.30	2.66	0.3899	0.1408	4	20.00	13	65.00	3	15.00
	Right	7.71	2.90			36	20.81	107	61.85	30	17.34

Source: No source

SD: Standard deviation; Below/Within/Above: Number (and %) of participants below/within/above normal range; *: $p<0.05$; #: $d>0.2$, ##: $d>0.5$, ###: $d>0.8$

For the Rhomberg task as depicted in Table 4.2 the participants from the quintile one school performed the best on average (mean = 29.19) and the participants from the quintile five school performed second best (mean = 28.36). Participants from quintiles two, three and four schools performed similar to each other, but scored lower than those from quintile one and five schools. Quintile two and four schools had the most participants perform this task below the norm (37.50% for quintile two schools and 27.85% for quintile four schools). There were none statistically or practically significant differences between genders in this task, but girls performed slightly better than boys, with 78.13% of girls and 73.20% of boys being within the norm. Hand preference is not relevant to the Rhomberg task as hands were kept relaxed next to the participants' body and is therefore not reflected in the results of this task.

Table 4. 2: Rhomberg

	Group					Below		Within	
		Mean	**SD**	**P-value**	***d*-value**	**N**	**%**	**N**	**%**
School Quintile	1	29.19	7.55	0.5766		7	21.88	25	78.13
	2	23.75	9.22			3	37.50	5	62.50
	3	25.89	7.49			14	22.22	49	77.78
	4	25.14	8.07			22	27.85	57	72.15
	5	28.36	3.67			1	9.09	10	90.91
Gender	Girls	26.00	6.09	0.7621	0.1253	21	21.88	75	78.13
	Boys	25.04	8.31			26	26.80	71	73.20

Source: No source
SD: Standard deviation; Below/Within/Above: Number (and %) of participants below/within/above normal range; *: $p<0.05$; #: $d>0.2$, ##: $d>0.5$, ###: $d>0.8$

Table 4.3 reflects results of the finger-to-nose task. When the task was carried out by the left hand, no statistically significant differences were found, however a practically significant effect (0.3460) is seen. A statistically significant difference with a small practical effect (0.3882) is reported when executing the task with the right, where the right-hand dominant participants performed better (p = 0.0125). When performing this task with the left arm, 75% of left-hand dominant participants fell within the norm (two to three successful repetitions), compared to a higher percentage of 78.61% of right-hand dominant participants being within the norm. When performing the task with the right hand, again a higher percentage of the right-hand dominant participants (84.96%) performed the task within the norm (two to three successful repetitions, compared to 80% of left-hand dominant participants falling within the norm.

Participants from the quintile five school performed worse than participants from all the other quintile schools, with a mean value of 1.82. This was followed by participants from the quintile two school (1.88), with participants from the quintile one (2.25), three (2.29) and four (2.54) schools performing similar to each other. However, differences between the school quintiles were not statistically significant. There were no statistically or practically significant differences between genders, as boys and girls performed very similar to each other for both the left and right arm.

Table 4. 3: Finger-to-nose

	Group					Below		Within	
		Mean	SD	P-value	*d*-value	N	%	N	%
Left hand									
School Quintile	1	2.25	1.08	0.4091		7	21.88	25	78.13
	2	1.88	1.55			3	37.50	5	62.50
	3	2.29	1.14			16	25.40	47	74.60
	4	2.54	0.87			12	15.19	67	84.81
	5	1.82	1.33			4	36.36	7	63.64
Gender	Girls	2.33	1.04	0.8106	0.0160	23	23.96	73	76.04
	Boys	2.35	1.10			19	19.59	78	80.41
Preferred Arm	Left	2.15	1.23	0.3998	0.3460#	5	25.00	15	75.00
	Right	2.36	1.05			37	21.39	136	78.61
Right hand									
School Quintile	1	2.44	0.95	0.5996		4	12.50	28	87.50
	2	1.88	1.55			3	37.50	5	62.50
	3	2.48	1.01			12	19.05	51	80.95
	4	2.65	0.73			8	10.13	71	89.87
	5	1.91	1.30			3	27.27	8	72.73
Gender	Girls	2.53	0.87	0.9034	0.1024	12	12.50	84	87.50
	Boys	2.43	1.04			18	18.56	79	81.44
Preferred Arm	Left	2.15	0.99	0.0125*	0.3882#	4	20.00	16	80.00
	Right	2.52	0.95			26	15.03	147	84.97

Source: No source
SD: Standard deviation; Below/Within/Above: Number (and %) of participants below/within/above normal range; *: p<0.05; #: d>0.2, ##: d>0.5, ###: d>0.8

The results for shoulder-level arm-raises are depicted below in Table 4.4. Data are presented for the preferred arm, non-preferred arm and for both arms.

Participants from quintile four schools performed better regarding preferred arm (81.01%) and non-preferred arm (82.28%), but the participants from quintile five school performed better using both arms (81.82%). The quintile two school performed the poorest when asked to use their non-preferred arm and both arms, with only 62.50% of children falling within the norm for both these execution options. Norms are two to four successful repetitions for the preferred arm and both arms and one to four successful repetitions for the non-preferred arm. A statistically significant difference ($p = 0.0288$) with a small practical effect (0.3139) was found between genders in the preferred arm, where boys performed better than girls when using their preferred arm (84.54% of boys fell into the norm and only 72.92% of girls) and their non-preferred arm (with 80.41% of boys in the norm and 76.04% of girls in the norm). Interestingly, girls (79.17% within the norm) outperformed boys (only 75.16% within the norm) when asked to use both arms to perform the task, however this difference is not of statistical significance. For left-hand dominant participants when using their preferred arm (mean = 3.05), non-preferred arm (mean = 3.10) and both arms (mean = 3.05) results show that left-hand dominant participants performed better than right-hand dominant participants on average, without statistically significant differences. For the Angels-in-the-snow and Finger-to-nose, the reverse was true.

Table 4. 4: Shoulder-level arm-raise

	Group					Below		Within	
		Mean	SD	P-value	*d*-value	n	%	N	%
Preferred arm									
School Quintile	1	2.72	1.57	0.3616		7	21.88	25	78.13
	2	2.75	1.83			2	25.00	6	75.00
	3	2.83	1.59			14	22.22	49	77.78
	4	3.08	1.51			15	18.99	64	81.01
	5	2.73	1.85			3	27.27	8	72.73
Gender	Girls	2.66	1.67	0.0288*	-0.3139#	26	27.08	70	72.92
	Boys	3.14	1.44			15	15.46	82	84.54
Preferred Arm	Left	3.05	1.50	0.6650		3	15.00	17	85.00
	Right	2.88	1.58			38	21.97	135	78.03
Non-preferred arm									
School Quintile	1	2.56	1.58	0.5382		7	21.88	25	78.13
	2	2.13	2.03			3	37.50	5	62.50
	3	2.60	1.66			14	22.22	49	77.78
	4	2.84	1.56			14	17.72	65	82.28
	5	2.27	2.00			4	36.36	7	63.64
Gender	Girls	2.55	1.66	0.2990	-0.1225	23	23.96	73	76.04
	Boys	2.75	1.61			19	19.59	78	80.41
Preferred Arm	Left	3.10	2.60	0.4377		2	10.00	18	90.00
	Right	1.25	1.67			40	23.12	133	76.88
Both arms									
School Quintile	1	2.78	1.54	0.3486		7	21.88	25	78.13
	2	2.25	1.98			3	37.50	5	62.50
	3	2.86	1.65			17	26.98	46	73.02
	4	2.97	1.48			15	18.99	64	81.01
	5	3.09	1.58			2	18.18	9	81.82
Gender	Girls	2.90	1.55	0.8207	0.0189	20	20.83	76	79.17
	Boys	2.87	1.60			24	24.74	73	75.26
Preferred Arm	Left	3.05	1.32	0.9362		3	15.00	17	85.00
	Right	2.86	1.60			41	23.70	132	76.30

Source: No Source

SD: Standard deviation; Below/Within/Above: Number (and %) of participants below/within/above normal range; *: p<0.05;#: d>0.2, ##: d>0.5, ###: d>0.8

Results for force perception task are presented in Table 4.5. There were no statistically significant differences regarding school quintiles or the preferred arm. However, quintile one (25%) and two schools 37.50%) had a higher percentage of participants below the norm (correctly identifying the hand which had the heavier object placed in) than quintile three (14.29%), four (12.66%) and five (18.18%) schools. A statistically significant difference between boys and girls was observed, where the girls outperformed the boys (p = 0.0322). 89.58% of girls fell within the norm and only 77.32% of boys were within the norm. There was no statistically significant difference between left-hand and right-hand dominant participants when executing this task.

Table 4. 5: Force perception

	Group		**Below**		**Within**	
		P-value	**n**	**%**	**n**	**%**
School Quintile	1	0.0993	8	25.00	24	75.00
	2		3	37.50	5	62.50
	3		9	14.29	54	85.71
	4		10	12.66	69	87.34
	5		2	18.18	9	81.82
Gender	Girls	0.0322*	10	10.42	86	89.58
	Boys		22	22.68	75	77.32
Preferred Arm	Left	0.7499	4	20.00	16	80.00
	Right		28	16.18	145	83.82

Source: No source
SD: Standard deviation; Below/Within/Above: Number (and %) of participants below/within/above normal range; *: p<0.05

4.4 Discussion

The aim of this study was to determine differences in kinesthetic coordination abilities of six-year-old children from different school quintile statuses, of different genders and with different hand dominance.

School quintile differences:

Findings of this study report different kinesthetic coordination abilities between participants from different quintile schools and SES backgrounds. Schools in South Africa are ranked according to a quintile ranking system ranging from one to five: with schools in lower SES areas being ranked as one to three and schools and in higher SES areas as four and five (Maistry & Africa, 2020). In the current study children in higher quintile schools (three, four and five) have in general better kinesthetic coordination abilities, compared to children in lower quintile schools (one and two) although not statistically significant. Results of a study done in Australia on a rather large sample size of 1288 six- to nine-year-old children where their FMS abilities, which included coordination abilities, were observed (Okely & Booth, 2004). Their results stated that children in higher status quintile schools have increased FMS abilities (more opportunities to practice) compared to children in lower quintile schools (Okely & Booth, 2004). In another study done in Turkey on 60 children between the ages of four to six years using the Bruininks-Oseretsky Test of Motor Proficiency, 2nd edition (BOT-2) (Balli, 2016), results indicated that SES had no effect on fine motor coordination skills, but that SES directly impacted participants' manual coordination, body coordination, strength and agility, as well as total motor score (Balli, 2016). In accordance with our findings, Balli (2016) stated that children in lower SES quintile schools have decreased motor coordination abilities compared to children in higher SES quintile schools (Balli, 2016). Hilpert, Brockmeier, Dordel, Koch, Weiß *et al.* (2017) tested children aged six's gross motor skills using the body coordination test for children and evaluating gender and SES. Hilper *et al.,* also corroborated the findings of our study by stating that children in high SES schools perform better in motor skills, while children in lower SES schools portray decreased motor skill performance. In studies done in South Africa research findings have contradicted the findings of the current study. Draper, Achmat, Forbes and Lambert (2012) have noted that children between the ages of four and six (n = 118) in low SES schools performed better in their gross motor skills than hypothesized. Tomaz, Jones, Hinkleyc, Bernsteina, Twine and fellow co-workers (2019) found that regardless of SES, three- to six-year-old children in South African populations of different SES had adequate motor skill proficiency levels when tested with the TGMD-2 and SES had no effect on motor skill proficiency (Tomaz *et al.,* 2019). This was not seen in our study as children in higher quintile schools performed better but not significantly better in the Angels-in-the-snow, finger-to-nose, shoulder-level-arm-raise and force perception tasks.

In the current study, children in lower quintile schools, however, outperformed children in higher quintile schools regarding the Rhomberg balancing task this could be because of more opportunities to practice balancing skills in their current environment as opposed to children living in higher SES areas. Dissimilarity findings are reported in a study done on over 2000 three-to-six-year-old children (Roth, Ruf, Obinger, Mauer, Ahnert *et al.,* 2010), where participants from low SES had low balancing skill abilities. Findings of our study are however consistent with other researchers in Norway who included 75 four to six-year-old participants (Fjørtoft, 2004). Fjørtoft (2004) found that children living in lower SES had better balancing skills when tested after a nine-month intervention period as compared to their peers living in higher SES areas. In another study done on South African on a sample size of 816 children with a mean age of 6.84 years in different SES schools in the North-West Province of South Africa, children from low SES significantly outperformed children from higher SES (Pienaar & Kemp, 2014). The findings of balancing abilities performed by the participants of the study done by Pienaar and Kemp (2014) is in accordance with our findings.

Gender differences:

Research states that minor differences exist between genders before the growth spurt and onset of adulthood (Malina *et al.,* 2004). Minimal gender differences in respect to six-year-old childrens's kinesthetic coordination were also observed in this study. Although differences were observed between boys and girls when they performed the Angels-in-the-snow, Rhomberg, finger-to-nose or force perception tasks, they were not significant. The only statistically significant difference between genders was observed when the preferred arm was used in the shoulder-level-arm-raise task, where boys outperformed the girls.

Although no studies to our knowledge have been done on gender differences and specifically the Angels-in-the-snow task the Angels-in-the-snow task require the use of unilateral, homolateral, bilateral and contralateral movements. Gidley-Larson, Mostofsky, Goldberg, Cuttinga and Denckla (2007) state that no significant gender differences occur in terms of seven- to fourteen-year-old children's bilateral coordination movements in the United States of America (USA) in a sample size of 144 girls and boys of typical development. Similarly, the current study also found no significant differences between genders, although girls performed slightly better than boys in Angels-in-the-snow task.

Static balancing tasks provide more distinctive differences in girls and boys before they enter the middle childhood stage (Mickle, Munro & Steele, 2011). Mickle and co-workers (2011) stated that between the ages of eight and twelve, boys (n = 37) in Australia performed poorer than girls (n = 47) during static and dynamic balancing tasks. This is in-line with the current study, although the better performance of girls was not significant compared to boys' performance in the Rhomberg task. A study conducted in New Zealand on a rather small sample size of only 26 children between the ages of eight and twelve supports the fact that girls performed better than boys in stability tasks (Smith, Ulmer & Wong, 2012). Our findings are also in agreement to a study done on specifically six static balance tasks on 543 children from different schools in the Republic of Ireland, children were between the ages four-to-fifteen-years (Condon & Cremin, 2013), and results correspond with our findings of girls outperforming boys in static balancing tasks. Findings are also consistent with findings of Pienaar *et al.,* 2016:10 on six-year-olds that showed that girls have improved balance (one-leg hops) over boys.

Regarding the finger-to-nose task, a study in the Taiwan area suggests, no gender differences in a group of 1365, nine- to twelve-year-old children (Li, Chen, Zhu & Wu, 2021). The task done by Li and co-workers (2021) was however done in a clinical setting and not field based but is still of value as it compares genders. A South African study did also not report any gender differences in a population and sample size of 528 six – to-thirteen-year-old children regarding the coordination used to perform the finger-to-nose task (Meyer & Sagvolden, 2006). In accordance with the above-mentioned studies, our findings did not support significant gender differences during the execution of the finger-to-nose task.

Shoulder-level-arm-raise findings of our study reported that boys performed better than girls when using their preferred and non-preferred arm (unilateral movements), while the contrast was reported when both arms were used, with girls outperforming boys (bilateral movements). In a study done on 84 four to eight-year-old children using motor sequencing items and bilateral coordination tasks, no differences in bilateral coordination were observed between genders (Cardoso & Magalhães, 2009). Another study done on five-year-old children using the BOT-2 short form, results for bilateral coordination under body coordination (jumping in place, with the same side synchronised) show no statistically significant differences between boys and girls (Matarma, Lagström, Löyttyniemi & Koski, 2020). The above findings are in contrast to our findings, as the current study found that boys performed better in unilateral movements of the shoulder-level-arm raise task, and girls performed better in the bilateral movements of the same task.

To our knowledge, no studies have been done exploring force perception as a kinesthetic coordination ability in six-year-old children. Therefore, no gender difference comparisons can be made between this study and other comparable studies. Findings of the current study do however state that girls significantly outperformed boys in this task.

Hand dominance differences

No significant differences were observed between right-hand and left-hand dominant children during execution of the Angels-in-the-snow, Rhomberg, shoulder-level-arm-raise and force perception tasks. However, for the finger-to-nose task, a statistically significant difference was noted between left- and right-handed dominant children were righ-handed dominant children performed better. Triggs, Calvanio, Levine, Heaton and Heilaman (2000) reported that hand dominance is related to the type of task performed (e.g., catching and throwing). In tasks that require usage of the right hand, right-hand dominant participants performed better with their right hand than their left hand and vice versa (Triggs e*t al.,* 2000). This was congruent with our findings during the finger-to-nose task.

4.6 Conclusion

Differences between school quintiles and performance in kinesthetic coordination abilities were observed, although these differences were not significant. Girls performed better than boys in the force perception task and boys outperfomred girls in the shoulder-level-arm-raise task. Significant differences were also seen in the performance of the finger-to-nose task with right-hand dominant participants perfomring better.

4.7 Limitations and Recommendations

The first limitations of this study were a low response rate regarding the receipt of consent forms. Although 400 consent forms were handed out, only 222 were received back. This low response rate could have partially been due to the Covid-19 pandemic which forced schools to work on a rotational attendance schedule and resulted in some children not being able to receive, or to bring back consent forms in time. Another limitation in the study was that some of the school quintile groupings only included one school per quintile (one, two and five), whereas other quintile groupings had more than one school representing that quintile status. However, the ratio of quintiles within the study is still seen as a good representative of the South African population as derived from the Manguang, Motheo district. Lastly, only hand dominance was observed where the role of leg dominance could also have played a role in kinesthetic coordination abilities of these six-year-old children. Another limitation identified was a language barrier at some of the school that toke part in the study, this was rectified by having the pre-trained interpreter present at all of the schools.

We recommend that more schools per quintile be used in further research with a larger sample size and including children of different age ranges. It is also recommended that leg dominance differences in kinesthetic coordination abilities be explored. Future research could also include tasks specifically evaluating spatial orientation and vestibular function, in conjunction with the five kinesthetic coordination tasks used in this study. It is recommended for movement specialists like Kinderkineticists in practice to use the five kinesthetic coordination tasks' norms to evaluate children, to effectively design a programme which would address backlogs identified. Specifically, Kinderkineticists should observe children in low SES areas and improve their kinesthetic coordination abilities, while balancing abilities of children in high SES areas should be a priority. Force perception abilities of boys should also be developed, by offering them with opportunities to practice these skills on the playground or by a movement specialist like a Kinderkineticist; while focus can be placed on left-hand dominant children's coordination abilities.

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CHAPTER 5

5.1 Summary

The aims of this dissertation were firstly to establish norms for kinesthetic coordination tasks in six-year-old children in the Mangaung, Motheo district, and secondly to determine differences in kinesthetic coordination abilities of six-year-old children from different school quintile statuses, of different genders and with different hand dominance.

Chapter one introduced the proprioceptive system and kinesthesia, which forms the basis for this dissertation.

Chapter one also focused on motor coordination and proprioception in the six-year-old child, motor development gender differences, as well as proprioceptive/kinesthetic coordination testing. Furthermore, chapter one discussed the problem statement, and the aims and objectives were derived from the problem statement. The methodology and ethical considerations were briefly discussed and a brief conclusion on all the topics relating to chapter one was given at the end of the chapter. This dissertation is presented in an article format style, as permitted by the senate of the University of the Free State (Bloemfontein campus). After chapter one this dissertation comprises of a literature review in chapter two and two research articles, one in chapter three and one in chapter four. These articles will be submitted for possible publication in accredited peer-review journals. This dissertation concludes with chapter five which presents the summary, conclusion, limitations and recommendations of the dissertation.

The literature review in chapter two elaborated on proprioception and kinesthesia, and the sensory systems during childhood. The discussion included literature on the childhood years, motor development during childhood and its link to proprioception/kinesthesia. Childhood development in general and childhood development in the South African context were also discussed. This was followed by discussion sections on motor coordination and motor control, the correlation between motor coordination and academic achievement, motor coordination and kinesthesia, as well as proprioceptive and kinesthetic coordination testing. Chapter two finished off with a conclusion based on all the topics discussed in the chapter.

Chapter three comprises out of article one titled: *Establishing normal ranges for kinesthetic coordination tasks in six-year-old children in the Mangaung, Motheo district*, written by C. Bonafede and E. de Waal. The main aim of this study was to establish normal ranges for kinesthetic coordination tasks in six-year-old children.

Children aged six from a variety of different quintile schools in the Mangaung, Motheo district participated in this study. The participant group amounted to 193 boys and girls of which 97 were boys and 96 were girls, with an average age of 6.46 years. Quantitative variables were summarized using descriptive statistics (mean, SD, minimum, P25, median, P75, maximum). Categorical variables were summarized using frequencies and percentages for variables indicating quality of movement. Normal ranges for six-year-old children were established based on the interquintile range (25^{th} and 75^{th} percentiles) of each variable, representing the middle 50% of data. Five kinesthetic coordination tasks were used to determine normal ranges. The results indicated and therefore the conclusion stated that normal ranges for each of the five tasks were successfully identified fir six-year-old children. For Angels-in-the-snow the normal range is set as six to ten successful executions (ability to perform the movement/s) out of the eleven consecutive movements required. 22 – 30 seconds of stationary balance is needed during the Rhomberg task, and for finger-to-nose task the normal ranges indicated that participants should be able to perform two to four successful repetitions (ability to perform the movements) with their left and right hand. The normal ranges for the shoulder-level-arm-raise tasks were two to four successful repetitions (ability to perform the movement/s) for the preferred arm and both arms, while one to four successful repetitions (ability to perform the movement/s) were indicated for the non-preferred arm. Lastly for force perception results indicated that children aged six should be able to correctly identify the force a heavier object exert on the body, compared to a lighter object.

The second article in chapter four is titled: *Kinesthetic coordination abilities in 6-year-old children: School quintile, gender, and hand dominance differences*, and written by C. Bonafede and E. de Waal. The aim of this study was to determine possible differences regarding school quintile status, gender and hand dominance on the kinesthetic coordination abilities of six-year-old children. 193 six-year-old boys (n=97) and girls (n=96) participated in this study from a variety of different quintile schools (one to five) in the Mangaung, Motheo district. Quantitative data was compared between genders, and hand dominance using the nonparametric Wilcoxon Two-sample test. The school quintiles were compared using the Cochran-Mantel-Haenszel (correlation) chi-square test. Fisher's exact test was used for comparison analysis of the binary variable force perception. The P-value is reported on ($p < 0.05$) and was regarded as statistically significant. Cohens *d* effect sizes were calculated for practical significance. The normal ranges from the article in chapter three were used to describe the differences between the mentioned variables. Regarding quintile status, participants from quintile three schools performed lower when compared to the other quintiles for the Angels-in-the-snow task. Girls performed slightly better than boys in the Angels-in-the-Snow task although not statistically different or practically significant, while no statistical differences were reported between left-hand and right-hand dominant children. Results for the Rhomberg task interestingly showed that participants from the quintile one school performed better compared to other quintile schools, although not significant. Girls again performed slightly better than boys but not practically significant. Hand dominance was not relevant and therefore not reported on. Finger-to-nose task results revealed that participants from the quintile five school performed the worst when compared to other quintile schools. No significant differences were observed for this task between boys and girls. A significant difference ($p = 0.0125$) and small practical significance (0.3882) did however occur between left and right dominant hand participants, with right-handed children performing better when using their right hand to perform the task. The shoulder-level-arm-raise task made use of the preferred arm, non-preferred arm and both arms. Results regarding school quintiles indicated that participants from quintile four schools performed better in the preferred arm and non-preferred arm tasks in comparison to other quintile schools, while participants from the quintile five school did better when usage of both arms were needed. There was a statistical significance between genders in the preferred arm execution of this task ($p = 0.0288$) and a small practical significance (0.3139) with boys performing better than girls. Girls did, however, outperform boys when asked to use both arms, although not significantly. During performance of the shoulder-level-arm-raise task the left-hand dominant participants mainly performed better, but not statistically significant. Lastly, for the force perception task results showed that participants from quintile three, four and five schools did better than participants from quintile one and two schools. Girls performed statistically better ($p = 0.0322$) than boys during the force perception task, while right-handed participants performed slightly better than left-hand participants. No practical significance for force perception was calculated.

5.2 Conclusions

The conclusions are derived from the aims and objectives in chapter one.

5.2.1 Aim one:

To establish norms for kinesthetic coordination tasks in 6-year-old children in the Mangaung, Motheo district.

This aim was successfully achieved and the norms for each one of the five kinesthetic coordination tasks were established. Angels-in-the-snow norms for a six-year-old child were set as six to ten successful repetitions. Rhomberg norms were set at 22 – 30 seconds for stationary balance. Finger-to-nose norms for the preferred arm was set at two to three successful repetitions, while for the non-preferred arm norms was set at one to three successful repetitions. Shoulder-level-arm-raise norms for preferred arm and both arms were set at two to four successful repetitions, and for non-preferred arm norms were set at one to four successful repetitions. Lastly, for the force perception task the norm indicated that six-year-old children should be able to correctly identify a heavier object when holding it.

5.2.2 Aim two:

To determine the effects of school quintile, gender and hand dominance differences on kinesthetic coordination abilities of 6-year-old children.

Findings of the second aim of this study concluded that participants in higher quintile schools overall had better results in the Angels-in-the-snow, finger-to-nose, shoulder-level-arm-raise and force perception tasks. Participants from lower quintile schools did however have better balance abilities as seen from the Rhomberg task execution. Gender differences, although small and mainly non-significant, were present in the kinesthetic coordination abilities of six-year-old children. Girls outperformed boys in the Angels-in-the-snow, Rhomberg, finger-to-nose and force perception tasks. A statistically significant difference was reported between genders in the performance of the shoulder-level-arm-raise task with the preferred arm, where boys outperformed girls. Minor hand dominance differences were observed and right-handed six-year-old children performed significantly better than left-handed children in the finger-to-nose task. Overall, the genders and school quintile status did not play a role in this article.

5.3 Limitations and Recommendations

5.3.1 Limitations:

This study had the following limitations:

- The COVID-19 pandemic influenced the schooling system, and learners had to attend school on a rotation basis. Therefore, not all children were present at school every day, impacting the number of learners available to be included in the study.
- A low response rate was received regarding returning of consent forms, while this could be a result of the pandemic, teachers not handing out forms and/or illiteracy of parents/guardians. All forms handed out were, however written in a native language spoken within the district.
- Only one quintile one, two and five schools were included in the data collection, whereas other quintiles had more schools per quintile. Although not all quintile schools were represented equally, the ratio of quintiles within the study sample could to an extent be seen as a good representative of the South African population.
- Only hand dominance was observed where the role of leg dominance could also have played a role in kinesthetic coordination abilities of six-year-old children.
- Another limitation is that only one age range (six-year-old children) was used to collect data on.

- Last limitation identified is the language barrier that existed between the main researcher/field workers and the children at the school this was however handled accordingly (the pre-trained interpreter was present at all of the schools).

5.3.2 Recommendations

The study acquired the following recommendations based on the results, as well as the limitations listed above:

- The main recommendation is that movement specialist practitioners in the field, and especially Kinderkineticists should use the established norms on six-year-old children in order to identify possible kinesthetic coordination delays. Delays should then be addressed with timely motor interventions to improve these young children's proprioceptive, kinesthetic and coordination abilities.
- Kinderkineticists and other movement specialists should observe children in low SES areas and improve their kinesthetic coordination abilities, with balancing abilities of children in high SES areas being the main focus. Force perception abilities of boys should also be better developed, and focus should be placed on left-hand dominant children's coordination abilities.
- It is recommended that the reliability and validity of these tasks be established in future.
- A larger sample size, as well as children from different age ranges, and from different provinces and districts in South Africa should be included in future research.
- The effects of hand and leg dominance on kinesthetic coordination abilities should be explored more in depth in future research endeavours.

Appendices

A: Child Information and Assent Form (English)

B: Child Information and Assent Form (Afrikaans)

C: Child Information and Assent Form (Sesotho)

D: Declaration of the interpreter

E: Department of Basic Education (DoBE) Letter of Approval

F: Early Childhood Development and Care Journal

G: Instruction booklet

H: Kinesthetic coordination test form

I: Parent Information and Consent Form (English)

J: Parent Information and Consent Form (Afrikaans)

K: Parent Information and Consent Form (Sesotho)

L: Principal Information and Consent Form (English)

M: Principal Information and Consent Form (Afrikaans)

N: Principal Information and Consent Form (Sesotho)

O: South African Journal of Childhood Education

Appendix A: Child Information and Assent Form (English)

PARTICIPANT INFORMATION LEAFLET AND ASSENT FORM

TITLE OF THE RESEARCH PROJECT: ***Establishing norms for kinesthetic coordination tasks in 6-year-old children in the Mangaung, Motheo District.***

RESEARCHERS NAME(S): Carmen Bonafede

ADDRESS: Department of Exercise and Sport Sciences

Faculty of Health Sciences

University of the Free State

South Africa

CONTACT NUMBER: 072 466 4665

***What is RESEARCH*?**

Research is something we do to help us find out new things about what we want to know.

What is this research project all about?

This study will help us know more about how you do some tasks and also help other people know how well you do these tasks.

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

You have been asked to take part in this study because of the school you are in and your age.

Who is doing the research?

Carmen Bonafede a Master's student and Kinderkineticist will be doing the research along with Dr Elna de Waal, and a number of fieldworkers from the University of the Free State.

What will happen to me in this study?

All that you will have to do is five short activities. For example:

- *You will have to lie on your back and move your arms and legs,*
- *stand with eyes closed,*
- *touch your nose with your fingers*
- *perform some arm movements and,*
- *hold a ball in each hand.*

By some of the tasks we will show you what to do and by the other tasks we will tell you what to do. Then you just have to do them.

 

Can anything bad happen to me?

Nothing bad can or will happen to you during this study. If at any time you feel like you don't want to take part anymore just come and tell us. You will then not have to do it anymore and you will not get into trouble for anything you say or do.

Can anything good happen to me?

You will be able to help us, and other people, know more about how your body moves.

Will anyone know I am in the study?

Only your parents, the principal, your teacher and we will know that you are taking part in this study. Your name will also not be mentioned anywhere during this project.

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

YES	NO

Has the researcher answered all your questions?

YES	NO

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

YES	NO

Do you want to participate?

__________________________ _____________________

Signature of Child Date

__________________________ _____________________

Signature of Witness Date

Appendix B: Child Information and Assent Form (Afrikaans)

DEELNEMER INLIGTINGSDOKUMENT EN TOESTEMMINGSVORM

TITEL VAN DIE NAVORSINGSPROJEK: ***Vasstelling van norme vir kinestetiese koördinasietake by 6-jarige kinders in die Mangaung, Motheo-distrik***

NAVORSER/S: Carmen Bonafede

ADRES: Departement Oefen- en Sportwetenskappe

Fakulteit Gesondheidswetenskappe

Universiteit van die Vrystaat

KONTAKNOMMER: 072 466 4665

Wat is NAVORSING?

Navorsing is iets wat ons doen om ons te help om nuwe dinge uit te vind oor wat ons wil weet.

Waaroor gaan hierdie navorsingsprojek?

Hierdie studie sal ons help om meer te weet oor hoe jy sekere take verrig en sal ook ander mense help om te weet hoe goed jy hierdie take verrig.

Hoekom is ek uitgenooi om aan hierdie navorsingsprojek deel te neem?

Jy is gevra om aan hierdie studie deel te neem oor die skool waar jy is en jou ouderdom.

Wie doen die navorsing?

Carmen Bonafeda, 'n meestersgraadstudent en kinderkinetikus, sal die navorsing saam met dr. Elna de Waal en 'n paar veldwerkers van die Universiteit van die Vrystaat doen.

Wat sal met my in hierdie studie gebeur?

Al wat jy sal moet doen, is vyf kort aktiwiteite.

Byvoorbeeld:

- *Jy sal op jou rug moet lê en jou arms en bene beweeg,*
- *met toe oë staan,*
- *jou neus met jou vingers raak,*
- *'n paar armbewegings doen en*
- *'n bal in elke hand hou.*

Met party van hierdie take sal ons vir jou wys wat om te doen en by die ander take sal ons vir jou sê wat om te doen. Dan moet jy dit net doen.

Kan enigiets sleg met my gebeur?

Niks sleg kan of sal met jou tydens hierdie studie gebeur nie. As jy op enige stadium voel jy wil nie meer deelneem nie, kom sê net vir ons. Dan sal jy dit nie meer hoef te doen nie en jy sal nie in die moeilikheid kom oor enigiets wat jy sê of doen nie.

Kan enigiets goed met my gebeur?

Jy sal ons en ander mense kan help om meer te weet oor hoe jou liggaam beweeg.

Sal enigiemand weet ek is in die studie?

Net jou ouers, die skoolhoof, jou onderwyser en ons sal weet dat jy aan hierdie studie deelneem. Jou naam sal ook nêrens tydens hierdie projek genoem word nie.

Verstaan jy hierdie navorsingstudie en is jy bereid om daaraan deel te neem?

JA	NEE

Het die navorser al jou vrae beantwoord?

JA	NEE

Verstaan jy dat jy enige tyd kan onttrek van die studie?

JA	NEE

Wil jy deelneem?

_____________________________ _______________________

Handtekening van kind Datum

_____________________________ _______________________

Handtekening van getuie Datum

Appendix C: Child Information and Assent Form (Sesotho)

PAMPITSHANA YA TLHAHISOLESEDING YA MONKAKAROLO LE FOROMO YA TUMELLO

SEHLOOHO SA PROJEKE YA PATLISISO: ***Ho theha maano bakeng sa kgokahanyo ya ditshebetso tsa motsamao baneng ba dilemo tse 6 ba Mangaung, Seterekeng sa Motheo***

(MA)LEBITSO LA MOFUPUTSI: Carmen Bonafede

ATERESE: Department of Exercise and Sport Sciences

Faculty of Health Sciences

University of the Free State.

NOMORO YA BOIKOPANYO: 072 466 4665

PATLISISO ke eng?

Patlisiso ke ntho eo re e etsang ho re thusa ho fumana mabapi le dintho tse ntjha tseo re batlang ho di tseba.

Projeke ee ya patlisiso hantle e mabapi le eng?

Phuputso ena e tla re thusa ho tseba haholwanyane mabapi le ka moo o etsang ditshebetso tse ding le hape ho thusa batho ba bang ho tseba hore na o etsa ditshebetso tsena hantle hakae.

Ke hobaneng ke memelwa ho ba karolo ya projeke ee ya patlisiso?

O kopilwe ho nka karolo phuputsong ena ka lebaka la sekolo seo o se kenang mme o dumela.

Ke mang ya etsang patlisiso ee?

Carmen Bonafede ke moithuti wa lengolo la Master's mme ke Setsebi sa Motsamao wa Mmele wa Bana mme o tlo etsa patlisiso mmoho le Ngaka Elna de Waal, le basebetsi ba mmalwa ho tswa Yunivesithing ya Foresitata.

Ho tla etsahalang ho nna phuputsong ee?

Sohle seo o tla hloka ho se etsa ke mesebetsi e mehlano e mekgutshwane. Ho etsa mohlala:

- *o tla lokela ho paqama ka mokokotlo mme ba tsamaise diphaka tsa hao le maoto,*
- *o eme ba kwetse mahlo a hao,*
- *o ithetsa dinko ka menwana ya hao*
- *o etse e meng ya metsamao le,*
- *ho tshwara bolo ka letsohong ka leng.*

Ka tse ding tsa ditshebetso re tla o bontsha hore na o etseng mme ka ditshebetso tse ding re tla o jwetsa hore o etseng. Jwale o tla lokela ho di etsa.

Na hona le se sebe se ka etsahalang ho nna?

Ha ho letho le lebe le ka etsahalang kapa le tla etsahala nakong ya phuputso ena. Haeba ka nako efe kapa efe o ikutlwa hore ha o sa batla ho nka karolo etlo feela o re jwetse. Jwale o ke ke wa hlola o sa hloka ho etsa letho mme o ke ke wa kena kgathatsong ka letho leo o le buang kapa o le etsang.

Na ho na le se setle se ka etsahalang ho nna?

O tla kgona ho re thusa, le batho ba bang, ho tseba haholwanyane mabapi le ka moo mmele wa hao o tsamayang ka teng.

Na ho na le motho ya ka tsebang hore ke kene phuputso ee?

Ke feela batswadi ba hao, mosuwehlooho, titjhere ya hao le rona ba tla tseba hore o nkile karolo phuputsong ena. Lebitso la hao hape le ke ke la bolelwa kae kapa kae nakong ya projeke ena.

Na o utlwisisa phuputso ena ya boithuto mme o ikemiseditse ho nka karolo ho yona.

E TJHE

Na mofuputsi o arabile dipotso tsohle tsa hao?

E TJHE

Na o utlwisisa hore o lokolohile ho ka tswa phuputsong ee ka nako efe kapa efe?

E TJHE

Na o batla ho nka karolo

 

______________________ ____________________

Tshaeno ya Ngwana Letsatsi

____________________ _____________________

Tshaeno ya Paki Letsatsi

Appendix D: Declaration of the interpreter

Declaration by interpreter

I *(name)* …………………………………………….……… declare that:

- I voluntarily acted as an interpreter for the above-mentioned study and partook, while knowing that I could withdraw at any time, and would not be compensated for my time.
- I have had adequate training/knowledge provided to me relating to the activities and how to properly explain to the learner what it is that they are expected to do.
- I assisted the researcher (*name*) ……………………………………… in explaining the information contained in this document to (*name of participant*) ………….………………………………….. by using the language medium of Afrikaans/English/Sotho.
- I encouraged the learner to ask questions and took adequate time to answer any questions the learner might have had.
- I conveyed a factually correct version of what was related to me.
- I read from the script as it was given to me and did not say anything that was not on the written explanations, and I did so to the best of my ability.

Signed at (*place*) ....……………….. on (*date*) …………..………………..

…………………………………………………………　　　　**……………………………………………………**

Signature of interpreter　　　　Signature of witness

Appendix E: Department of Basic Education Approval

Enquiries: KK Motshumi
Ref: Research Permission: Bonafede C and 16 co-researchers whose names appear in paragra[ph] Department of Education application form
Tel. 051 404 9283 / 9221 / 079 503 4943Email: K.Motshumi@fseducation.gov.za

education
Department of Education
FREE STATE PROVINCE

C Bonafede
67 Gascony Crescent
Helicon Heights
Bloemfontein
9301

Dear Ms. Bonafede

APPROVAL TO CONDUCT RESEARCH IN THE FREE STATE DEPARTMENT OF EDUCATION

1. This letter serves as an acknowledgement of receipt of your request to conduct research in the Free State Department of Education.

   Topic: Establishing norms for Kinesthetic coordination tasks in 6 year olds in the Mangaung Motheo District.

   List of schools involved: Atang, Bloemfontein Oos, Fauna, Joe Solomon, Lesedi, Mangaung, Olympia, Rekgonne, Relebeletse and Toka Primary Schools.

2. **Target Population:** 360 low to high socio-economic status children in Grade R.

3. **Period of research:** From date of signature of this letter until 30 September 2020. Please note that the department does not allow any research to be conducted during the fourth term (quarter) of the academic year. Should you fall behind your schedule by three months to complete your research project in the approved period, you will need to apply for an extension.

4. The approval is subject to the following conditions:

   4.1 The collection of data should not interfere with the normal tuition time or teaching process.

   4.2 A bound copy of the research document or a CD, should be submitted to the Free State Department of Education, Room 319, 3rd Floor, Old CNA Building, Charlotte Maxeke Street, Bloemfontein.

   4.3 You will be expected, on completion of your research study to make a presentation to the relevant stakeholders in the Department.

   4.4 The ethics documents must be adhered to in the discourse of your study in our department.

5. Please note that costs relating to all the conditions mentioned above are your own responsibility.

Yours sincerely

DR JEM SEKOLANYANE
CHIEF FINANCIAL OFFICER

DATE: 23/03/2020

RESEARCH APPLICATION C. BONAFEDE AND OTHERS WHOSE NAMES APPEAR IN THE DEPARTMENTAL RESEARCH APPLICATION FORM, PERMISSION 09 03 2020 MOTHEO DISTRICT

Strategic Planning, Policy & Research Directorate
Private Bag X20565, Bloemfontein, 9300 - Room 318, Old CNA Building, 3rd Floor, Charlotte Maxeke Street, Bloemfontein
Tel: (051) 404 9283 / 9221 Fax: (086) 6678 678

Enquiries: KK Motshumi
Ref: Notification of research: Bonafede C and 16 co-researchers whose names appear in parag... Department of Education application form
Tel. 051 404 9221 / 079 503 4943
Email: K. Motshumi@fseducation.gov.za

education
Department of Education
FREE STATE PROVINCE

District Director
Motheo District

Dear Mr Moloi

NOTIFICATION TO CONDUCT RESEARCH PROJECT IN YOUR DISTRICT BY C BONAFEDE AND 16 CO-RESEARCHERS WHOSE NAMES APPEAR IN PARAGRAPH 26 OF THE DEPARTMENT OF EDUCATION APPLICATION FORM

The above mentioned candidate was granted permission to conduct research in your district as follows:

1. **Topic:** Establishing norms for Kinesthetic coordination tasks in 6 year olds in the Mangaung Motheo District.

   List of schools involved: Atang, Bloemfontein Oos, Fauna, Joe Solomon, Lesedi, Mangaung, Olympia, Rekgonne, Relebeletse and Toka Primary Schools.

   Target Population: 360 low to high socio-economic status children in Grade R.

2. **Period:** From the date of signature of this letter until 30 September 2020. Please note the department does not allow any research to be conducted during the fourth term (quarter) of the academic year nor during normal school hours.

3. **Research benefits:** The results of the study will broaden an understanding of Kinesthetic coordination ability in children and provide a way of measuring and comparing South African children and pave a way for further research within this field.

4. Logistical procedures were met, in particular ethical considerations for conducting research in the Free State Department of Education.

5. Strategic Planning, Policy and Research Directorate will make the necessary arrangements for the researchers to present the findings and recommendations to the relevant officials in the district.

Yours sincerely

DR JEM SEKOLANYANE
CHIEF FINANCIAL OFFICER

DATE: 23/03/2020

RESEARCH C BONAFEDE AND 16 OTHERS, NOTIFICATION 09 03 2020, MOTHEO DISTRICT
Strategic Planning, Research & Policy Directorate
Private Bag X20565, Bloemfontein, 9300 - Old CNA Building, Room 319, 3rd Floor, Charlotte Maxeke Street, Bloemfontein
Tel: (051) 404 9283 / 9221 Fax: (086) 6678 678

Appendix F: Early Childhood Development and Care Journal

Author Guidelines:

https://www.tandfonline.com/action/authorSubmission?show=instructions&journalCode=gecd20

Appendix G: Instruction Booklet

Instruction Booklet for the execution of the task items to be read by the interpreter

1. **Angels-in-the-snow task**

Please lie on your back and make sure that your body in is the middle on the line on the mat. We will point to the arms or legs that you will need to move. Please make sure you move your arms and legs along the mat and do not lift it up. Make sure to return them to the same place in which you started. You will need to do each movement four (4) times.

a. Move both your arms and legs.
b. Move both arms.
c. Move both legs.
d. Move your right arm only.
e. Move your left arm only.
f. Move your right leg only.
g. Move your left leg only.
h. Move your right arm and right leg.
i. Move your left arm and left leg.
j. Move your right arm and left leg.
k. Move your left arm and right leg.

2. Rhomberg task

Please stand with your feet together and next to each other. Try to stand up nice and tall and not fall over. You will do this with your eyes closed. You will try to hold this position for 30 seconds or as long as you can.

3. Finger-to-nose task:

Stand up nice and straight with your arms to shoulder level and extended straight out. Then touch the tip of your nose with your index finger and then return arm to the starting position then do this with your other arm. You can first do it with your eyes open and then you need to do it with your eyes closed, keep going until I tell you to stop.

4. Shoulder level arm-raise task:

Please stand up and raise your arms in front of you at the same level of your shoulders. You need to do this with eyes closed and do each movement four times.

a. First raise your arm that you write with in front of you four times.

b. Repeat the movement by using your other arm to also do this four times.

c. And then raise both arms in front of you, four times.

5. Force perception:

Please stand up and with both your arms raised out in front of you at the same level as your shoulders. We are going to put a weight in each hand, and you just need to tell us which hand has the heavier weight in it. You will need to close your eyes when you do this. You will only be doing it once.

We are done. Thank you so much for your help, you did a good job.

Appendix H: Kinesthetic Coordination Test Form

Kinesthetic Coordination ★

Gender

M	F

Weight kg:	
Height cm:	

Participant amount:	
Sequence amount:	
Sequence:	

	Year	Month	Day
Date tested:			
Date of birth:			
Chronological Age:			

Test	Score
Angels-In-The-Snow	
Rhomberg	
Finger-to-nose	
Shoulder level arm raise	
Force Perception	

A. Angels-in-the-Snow Test

Exercise:	YES	NO	Repetitions	Score
1. Move all four limbs at the same time.			/4	
2. Move the two arms.			/4	
3. Move the two legs.			/4	
4. Move right arm only.			/4	
5. Move left arm only.			/4	
6. Move right leg only.			/4	
7. Move left leg only.			/4	
8. Move the right arm and the right leg.			/4	
9. Move the left arm and the left leg.			/4	
10. Move the right arm and left leg.			/4	
11. Move the left arm and right leg.			/4	

Quality of the movement:									
Associated movements are present:		Movements are uncoordinated:		Child moves with hestitation:		Child looks at limb/s		Child touches or bangs limb/s	
YES	NO	YES	NO	YES	NO	YES	NO	YES	NO

Notes/Observations

B. Rhomberg Test

	Trail 1	Trail 2
Number of seconds: (Max 30 seconds)		

Preferred leg	
R	L

	Observed if movement occurs:							
	Loss of balance occurs		Child weaves back and/ or forth		Child lifts or moves one or both feet apart		Child lifts one or both arms	
Trail 1	YES	NO	YES	NO	YES	NO	YES	NO
Trail 2	YES	NO	YES	NO	YES	NO	YES	NO

Notes/Observations

C. Finger-to-Nose Test:

Eyes closed

	Amount completed: (Max: 6)
Right hand:	
Left hand:	

Quality of the movement:											
Movements are unusually fast or slow		Moves hand consistently to right or left		Moves hand consistently to top or bottom		Misses nose by 1 - 2,5cm		Misses tip of nose by more than 1cm		Movements are random or unsteady	
YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO

Notes/Observations

D. Shoulder-Level Arm-Raise Test:

Preferred arm	
R	L

	Amount completed: (Max:4)
Preferred arm:	
Non-preferred arm:	
Both:	

Quality of the movement:							
Wrist drop occurs		Arms doesn't go the same level each time		Incorrect body position		Body sways back and forth and or bends forward or backwards	
YES	NO	YES	NO	YES	NO	YES	NO

Notes/Observations

E. Force Perception:

Eyes Closed

Weight of ball	
500g	1kg

	Weight of ball:	Correct hand identified
Right arm:	☐	YES / NO
Left arm:	☐	

Quality of the movement:
Child sways/moves body in any direction YES / NO

Notes/Observations

Appendix I: Parent Information and Consent Form (English)

HEADMASTER/PRINCIPAL OF SCHOOL INFORMATION LEAFLET AND CONSENT FORM

TITLE OF THE RESEARCH PROJECT: Establishing norms for kinesthetic coordination tasks in 6-year-old children in the Mangaung, Motheo District

REFERENCE NUMBER: (UFS-HSD2020/0143/210)

PRINCIPAL RESEARCHER: Carmen Bonafede

ADDRESS: Department of Exercise & Sport Science

Faculty of Health Sciences

University of the Free State, South Africa

CONTACT NUMBER: 072 466 4665

You are being invited to allow the participation of your school in this research study. Please take some time to read the information presented here, which will explain the details of this study. Please ask anyone involved in this study any questions about any part of this study that you do not fully understand. It is very important that you are fully satisfied, that you clearly understand what this research entails, and how you could be involved. Also, the participation of the school is **entirely voluntary,** and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw your school's consent from the study at any point, even if you initially do agree to take part. The Department of Basic Education provides approval for the study to commence, and you need to provide permission for the research to be done at your school.

This study has been approved by the Health Sciences Research Ethics Committee at the University of the Free State (UFS-HSD2020/0143/210) and will be conducted according to the ethical guidelines and principles of the South African Guidelines for Good Clinical Practice and the Medical Research Council (MRC) Ethical Guidelines for Research.

What is this research study about?

This study aims to set out values that will help us know more about the way in which six-year-old children move their bodies. The study aims to determine the function of their kinesthetic and proprioceptive system, meaning how well they use sensory information coming from inside their bodies, while they do different motor activities. There is currently not a lot of knowledge on norms for kinesthetic coordination tasks for South African children and the researcher would like to gain more information on this important topic. This would enable individuals in practice and in the academic field to know more about the kinesthetic and proprioceptive abilities of children since problems in these children could result in poor academic performance.

Six-year-old children in schools within the Mangaung, Motheo District will be selected to take part in the study. Children's names will not be shown on any of the forms, which mean that information will be kept confidential. Participants will be selected according to their age and consideration will be given to the quintile status of their school. In order to participate in this study children therefore need to be six years old at the time of data collection.

The children will be asked to do five different tasks, like touching their finger to their nose or balancing. The researcher and trained field workers will first explain to them what to do and how to do the activities. If at any time any of the children do not want to participate anymore, they can just inform the researcher and thereafter they will be excluded from participation. No negative consequences will follow if they do not want to participate anymore.

If the children do not understand what it is that they are supposed to do, a trained interpreter will assist when needed, in order to interpret what is being said to the children. The researcher may ask a teacher or other employee of the involved school to act as an interpreter if permission is given by yourself and the relevant teacher/employee. The interpreter will firstly be trained to explain the activities and they will also be asked to sign a declaration to state that they provide consent to accurately assist the researcher in the research study. They will also be asked to read from a set out script to make sure that task instructions are carried out correctly by the children.

The study will be done at approximately 10 schools in the Mangaung, Motheo District. After the selection of the schools (taking school quintile into account), the first 20 – 40 children (depending on the number selected for the school by the biostatistician) for whom informed consent is obtained will be included in the study sample. It will be stated on the permission documents that even if the parent/guardian of the child receives the information and consent forms and completes and returns the forms in due time, it is not to say that the child is guaranteed participation in this study.

Why have you been invited to participate?

Your school has been selected for participation in this study because it is relatively close to the University of the Free State's main campus, and it falls into the specific school quintile to make the study representative of the South African population.

What will your responsibilities be?

As the principal of the school, we ask that you provide permission for us to conduct the study at your school and allow each selected participant to partake in the set activities for 10 - 15 minutes. The time of the research will be done in a time that is given to us by you as to ensure that it does not affect the children's learning opportunities in any way. The parents of the learner's will also have to provide permission for their child to partake in the study. The children involved will also have to provide assent where after they will physically perform the activities. The researcher therefore also asks for permission to distribute consent forms to the parents, via the school.

Will you benefit from taking part in this research?

You will be helping the researcher and other professionals in child development to gain knowledge on how six-year-old children's bodies move and how they perform different activities. This will also help us know why for example children slouch in their chairs at school or are clumsy when participating in physical activities.

Are there any risks involved in your taking part in this research?

There are no major risks involved in this study. Due to activities being physical of nature it may cause slight physical discomfort or muscle soreness may occur during or after participation. The researcher and field workers do, however, have Level 1 first aid and will be able to provide care in the unlikely case of any injury that might occur due to the activities or any other factors outside of the researchers' control.

Will you be paid to take part in this study and are there any costs involved?

Participation is voluntary and therefore no one will be paid for their participation in the study. There will be no costs involved for you or the parents.

Is there anything else that you should know or do?

- Know that consent and assent are voluntary and that you as the principal are free to withdraw your school at any time during the study.
- You can contact Carmen Bonafede at 072 466 4665 or Dr Elna de Waal at 051 401 2467 if you have any further queries or encounter any problems.
- You can contact the Health Sciences Research Ethics Committee at the University of the Free State at 051-401 7794/5 if you have any concerns or complaints that have not been adequately addressed.

Declaration by principal (Head of school)

By signing below, I ……………………………………............. agree to let the following research study take place at my school: ***Establishing norms for kinesthetic coordination tasks in 6-year-old children in the Mangaung, Motheo District.***

I declare that:

- I have read this information and consent form and it is written in a language with which I am fluent and comfortable.
- I have had an opportunity to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I may choose to withdraw consent at any time and will not be penalised or prejudiced in any way.
- I may be asked to withdraw my consent from the study before it has finished, if the researcher feels it is in the best interests of the child, or if the child does not follow the study plan, as agreed to.

Signed at (*place*) ....………... on (*date*) …………....…….. 20...

.. **..**

Signature of principal (Head of school) Signature of witness

Declaration by main researcher

I *(name)* …………………………………………….……… declare that:

- I explained the information in this document to …………………………………..
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above.
- I did/did not use an interpreter. (*If an interpreter is used then the interpreter must sign the declaration below.*

Signed at (*place*) ....…........………………. on (*date*) ……….....……….. 20….

……………………………………………………….. **……………………………………………………**

Signature of main researcher Signature of witness

Appendix J: Parent Information and Consent Form (Afrikaans)

INLIGTINGSTUK EN TOESTEMMINGSVORM VIR OUER/VOOG

TITEL VAN DIE NAVORSINGSPROJEK: Vasstelling van norme vir kinestetiese koördinasietake by 6-jarige kinders in die Mangaung, Motheo-distrik.

VERWYSINGSNOMMER: UFS-HSD2020/0143/210

HOOFNAVORSER: Carmen Bonafede

ADRES: **Departement Oefen- en Sportwetenskappe**

Fakulteit Gesondheidswetenskappe

Universiteit van die Vrystaat, Suid-Afrika

KONTAKNOMMER: 072 466 4665

U kind word uitgenooi om deel te neem aan hierdie navorsingstudie. Lees asseblief hierdie inligting wat die besonderhede van die studie verduidelik. Vra asseblief vir enigiemand wat betrokke is by die studie as iets onduidelik is. Dit is baie belangrik dat u heeltemal tevrede is met die inligting, en dat u ten volle verstaan wat hierdie navorsing behels en hoe u kind betrokke kan wees. U kind se deelname is **volkome vrywillig** en u mag dit van die hand wys. Indien u nee sê, sal dit geen negatiewe gevolge hê op u of u kind nie. U kind mag enige tyd van die studie onttrek, selfs as u aanvanklik ingestem het vir u kind om deel te neem. Die Departement van Basiese Onderwys keur die studie goed en u moet toestemming gee dat die navorsing by u kind se skool gedoen word.

Hierdie studie is goedgekeur deur die Gesondheidswetenskappe se Navorsing Etiekkomitee van die Universiteit van die Vrystaat (UFS-HSD2020/0143/210). Dit sal gedoen word volgens die etiese riglyne en beginsels van die Suid Afrikaanse Riglyne vir Goeie Kliniese Praktyk en die Raad vir Mediese Navorsing (RMN) se Etiese Riglyne vir Navorsing.

Waaroor gaan die navorsingstudie?

Hierdie studie beoog om waardes daar te stel wat ons sal help om meer te weet oor hoe ses-jarige kinders hulle liggame beweeg. Die doel van die studie is om die funksie van kinders se kinestetiese en proprioptiewe stelsel vas te stel. Dit beteken, hoe goed hulle sensoriese inligting van buite hulle liggame gebruik terwyl hulle verskillende motoriese aktiwiteite uitvoer. Daar is tans nie baie kennis oor norme vir kinestetiese koördinasietake vir Suid-Afrikaanse kinders nie en die navorser wil meer inligting kry oor hierdie belangrike onderwerp. Dit sal praktisyns en akademici meer leer oor die kinestetiese en proprioseptiewe vermoëns van kinders omdat kinders met sulke probleme akademies swak presteer.

Ses-jarige kinders in van die skole in die Mangaung en Motheo-distrik sal gekies word om deel te neem aan die studie. Kinders se name sal nie op enige van die vorms verskyn nie en dus sal inligting vertroulik wees. Deelnemers sal op grond van hul ouderdom gekies word en die kwintielstatus van die skool sal in ag geneem word. Om aan die studie deel te neem moet kinders dus ses jaar oud wees wanneer data ingesamel word.

Die kinders sal vyf verskillende take moet uitvoer, soos om hulle neuse met hul vingers raak of te balanseer. Die navorser en opgeleide veldwerkers sal eers aan hulle verduidelik wat om te doen en hoe om die aktiwiteite te doen. As die kinders op enige stadium nie meer wil deelneem nie, kan hulle net vir die navorser so sê. Daarna sal hulle van die studie uitgesluit word – sonder enige nagevolge.

Indien die kinders nie die opdragte verstaan nie, sal ŉ opgeleide tolk hulle help. Die navorser mag ŉ onderwyser of ander werknemer van die skool vra om as tolk op te tree – indien u en die betrokke onderwyser/werknemer toestemming gee. Die tolk sal eers opgelei word om die aktiwiteite te verduidelik en sal ŉ verklaring teken dat hulp aan die navorser en die navorsingstudie akkuraat sal wees. Die tolk sal ook van ŉ voorbereide dokument aflees om te verseker dat die kinders die instruksies korrek volg.

Die studie sal by ongeveer 10 skole in die Mangaung, Motheo-distrik gedoen word. Nadat skole gekies is (met hulle kwintiele in ag geneem), sal die eerste 20 – 40 kinders gekies word. Die getal kinders in die steekproef word deur die biostatistikus bepaal en hang af van die hoeveelheid kinders wat ingeligte toestemming ontvang. Die toestemmingsdokumente sal meldnoem dat kinders nie noodwendig aan die studie sal deelneem nie – selfs al dien hul ouers/voogde die voltooide toestemmingsvorms betyds in.

Hoekom is u genooi om deel te neem?

U kind se skool is gekies vir die studie omdat dit relatief naby aan die Universiteit van die Vrystaat se hoofkampus is en ook binne die spesifieke kwintiele, wat verteenwoordigend van die Suid-Afrikaanse bevolking is, val.

Wat sal u verantwoordelikhede wees?

As ouer/voog word u versoek om toestemming te gee dat u kind deel van die studie vorm. Die kinders se onderrigtyd gaan nie benadeel word nie. Die skoolhoof sal ook moet toestemming gee dat hulle aan die studie deelneem. Die betrokke kinders sal moet toestem om sekere aktiwiteite te doen.

Sal u voordeel trek uit u deelname aan die navorsing?

U sal die navorser en ander professionele persone betrokke met kinderontwikkeling help om kennis in te win oor ses-jariges se liggaamsbeweging en hoe hulle verskillende aktiwiteite uitvoer. Dan kan ons weet hoekom kinders byvoorbeeld nie ’n behoorlike liggaamshouding inneem wanneer hulle op hul stoele in die skool sit nie, of lomp is wanneer hulle aan fisiese aktiwiteite deelneem.

Is daar enige risiko’s verbonde aan deelname aan die navorsing?

Daar is geen groot risiko’s verbonde aan hierdie studie nie. Omdat die aktiwiteite fisiek is, kan geringe fisieke ongemak of seer spiere tydens of na deelname voorkom. Die navorser en die veldwerkers het egter vlak-1 noodhulpopleiding en sal bystand kan bied in die onwaarskynlike geval van beserings of ander faktore buite die navorser se beheer.

Sal u betaal word om deel te neem aan die studie en beloop dit enige onkoste?

Deelname is vrywillig en gevolglik sal niemand betaal word om deel te neem nie. Daar sal geen onkoste vir u of die skool wees nie.

Is daar enigiets anders wat u moet weet of doen?

- U moet weet dat toestemming vrywillig is en dat u as ouer enige tyd u kind van die studie mag onttrek.
- U kan enige tyd vir Carmen Bonafede by 072 4466 4665 of vir Dr Elna de Waal by 051 401 2467 skakel as u navrae of probleme het.
- U kan die Gesondheidswetenskappe se Navorsingsetiek Komitee van die Universiteit van die Vrystaat by 051-401 7794/5 skakel as enigiets u bekommer of indien klagtes nie genoegsaam gehanteer is nie.

Verklaring deur die ouer/voog

Deur die onderstaan te teken, gee Ek ………………………………….……………. toestemming dat my kind deel kan vorm van die volgende navorsingstudie: ***Vasstelling van norme vir kinestetiese koördinasie-take by 6-jarige kinders in die Mangaung, Motheo Distrik.***

Ek verklaar dat:

- Ek die inligting en toestemmingsdokument gelees het en dat dit geskryf is in 'n taal waarin ek vlot en gemaklik is.
- Ek 'n geleentheid gehad het om vrae te vra en dat dit voldoende beantwoord is.
- Ek verstaan dat deelname aan hierdie studie **vrywillig** is en dat daar nie druk op my geplaas is om deel te neem nie.
- Ek enige tyd my toestemming mag onttrek en nie gepenaliseer of teen gediskrimineer sal word nie.
- Ek gevra kan word om my toestemming van die studie te onttrek voordat dit eindig as die navorser voel dit is in die beste belang van die kind of indien hy/sy nie die ooreengekome studieplan volg nie.

Geteken te (*plek*) ....………….. op (*datum*) …………….….. 20...

………………………………………………………………… ………………………………………………………………

Handtekening van die ouer/voog Handtekening van getuie

Verklaring deur die hoofnavorser

Ek *(naam)* …………………………………………..……… verklaar dat:

- Ek die inligting in hierdie dokument verduidelik het aan …………………………………..
- Ek het hom/haar aangemoedig om vrae te vra en het genoeg tyd geneem om dit te beantwoord.
- Ek is tevrede dat hy/sy al die aspekte van die navorsing, soos hierbo bespreek, verstaan.
- Ek het/het nie ’n tolk gebruik (nie). *As ’n tolk gebruik is, moet hy/sy die onderstaande verklaring teken*.

Geteken te (*plek*) ....…..................….. op (*datum*) …………..……. 20….

....

Handtekening van hoofnavorser Handtekening van getuie

Appendix K: Parent Information and Consent Form (Sesotho)

PAMPITSHANA YA TLHAHISOLESEDING LE FOROMO YA TUMELO YA MOTSWADI/MOHLOKOMEDI

SEHLOOHO SA PROJEKE YA PATLISISO: Ho theha maano bakeng sa kgokahanyo ya ditshebetso tsa motsamao baneng ba dilemo tse 6 ba Mangaung, Seterekeng sa Motheo

NOMORO YA REFERENSE: UFS-HSD2020/0143/2104-0001

MOFUPUTSI WA SEHLOOHO: Carmen Bonafede

ATERESE: Department of Exercise and Sport Sciences

Faculty of Health Sciences

University of the Free State

NOMORO YA BOIKOPANYO: 072 466 4665

Motswadi/mohlokomedi ya hlomphehang

Lebitso la ka ke Carmen Bonafede mme ke moithuti wa lengolo la Master’s mme ke Setsebi sa tsa Metsamao ya Mmele ya Bana se rupetsweng. Setsebi sa tsa Metsamao ya Mmele ya Bana ke motho ya sebetsanang le bana ka ho ba dumella ho ntlafatsa ka moo ba tsamaisang mmele ya bona le hore ba sebetsa hantle hakae ho tsamaiseng mmele ya bona ho hoholo jwalo ka ho kapa bolo. Phuputso ena e tla re thusa ho tseba haholwanyane mabapi le hroe na bana ba etsa ditshebetso tse ding jwang le hape ho thusa batho ba bang ho tseba hore na bana ba etsa ditshebetso tsena hantle hakae.

Ka kopo iphe nako ya ho bala tlhahisoleseding e fanweng mona, e tla hlalosa dintlha tse feletseng ka phuputso ena mme o ikopanye le nna haeba o hloka tlhakisetso kapa tlhalosetso e eketsehileng kapa haeba o se na bonnete mabapi le ntlha efe kapa efe ya phuputso. Hape, bonkakarolo o bo etsa **ka**

boithaopo bo feletseng, e leng se bolelang hore ha o tlameha ho dumela hore ngwana wa hao a nke karolo mme o lokolohile ho ka hula bonkakarolo ba hae ka nako efe kapa efe. Haeba o re tjhe, sena se ke ke sa ama wena kapa ngwana wa hao ka tsela e seng ntle jwang kapa jwang. Ngwana wa hao o lokolohile ho ka ikgula phuputsong ka nako efe kapa efe, esita leha eba o etsa qeto ya hore ngwana wa hao a nke karolo mme ngwana wa hao a dumela ho nka karolo.

Phuputso ena e fuwe tumello ke

Komiti ya Boitshwaro ya Dipatlisiso tsa Disaense tsa Bophelo (Health Sciences Research Ethics Committee (HSREC) ya Yunivesithi ya Foreistata (UFS-HSD2020/0143/2104-0001) mme e tla tsamaiswa ho latela melawana e amohelwang le ho sebetsa ya Naha le ya Matjhaba ya boitshwaro le maano.

Sohloe seo ngwana wa hao a tla hloka ho se etsa ke ho latela diketso tse latelang tse hlano tse kgutshwane:

- Ba tla lokela ho paqama ka mokokotlo mme ba tsamaise diphaka tsa bona le ma
- ba eme ba kwetse mahlo a bona,
- ba thetse dinko tsa bona ka menwana ya bona,
- ba etse e meng ya metsamao le,
- ho tshwara bolo, ba boima bo fapaneng, ka letsohong ka leng.

Ba tla bontsha kapa ba jwetswe seo ba lokelang ho se etsa ebe ba etsa ketso eo.

Phuputso e tla etswa dikolong tse ka bang 10 tsa Mangaung, Seterekeng sa Motheo. Mookamedi wa sekolo ka seng se amehang o se a fane ka tumelo ya hore phuputso e ka etswa sekolong mme ke ka hona o fuweng foromo ena. O lokela ho dumela hore ngwana wa hao a ka nka karolo phuputsong ena. Mofuputsi o tla kopa bana ba 20 – 40 sekolong ka seng ho nka karolo. Ho nka diforomo tsa pele tse amohetsweng tse 20 – 40 sekolo ka seng, ho tla re tumella ho kgetha ban aba tla nka karolo phuputsong. Esita leha foromo ya hao e tlatsitswe sena ha se bolele hore ngwana wa hao o tla feela a nke karolo phuputsong, ke feela diforomo tsa pele tsa tumelo tse amohetsweng tse tla lebisa kenyeletsong. Hape o ke ke wa fumana tjhelete hore ngwanawa hao a nke karolo phuputsong ena.

Haeba o na le dipotso dife kapa dife kapa haeba o se na bonnete ka eng kapa eng, ka kopo ikopanye le nna (Carmen Bonafede) kapa *Health Sciences Research Ethics Committee* (HSREC) dinomorong tse latelang tsa mohala kap ahaeba o batla ho romela imeile, o ka etsa jwalo.

Carmen Bonafede (Mofuputsi wa Sehlooho) – 072 466 4665 carmenbonafede@gmail.com

HSREC - 051 401 7795 hsrecfhs@ufs.ac.za

Haeba o ikemiseditse ho dumella ngwana wa hao ho nka karolo phuputsong ena, ka , kopo saena Boikano ba Tumelo bo hoketsweng mona mme o e fe titjhere ya sehlopha ya ngwana wa hao.

Ba hao ka boikokobetso

____

Carmen Bonafede

Mofuputsi ya ka Sehloohong

Boikano ba motswadi/mohlokomedi wa molao

Ka ho saena ka tlase mona, nna ………………………………….…………. ke dumela ho dumella ngwna wa ka ho nka karolo phuputsong ya boithuto e bitswang Ho theha maano bakeng sa kgokahanyo ya ditshebetso tsa motsamao baneng ba dilemo tse 6 ba Mangaung, Seterekeng sa Motheo

Ke ikana hore:

- Ke badile pampitshana ya tlhahisoleseding e hoketsweng mona mme e ngotswe ka puo eo ke e utlwisisang.
- ke bile le monyetla wa ho botsa dipotso mme dipotso tsohle tsa ka di arabilwe.
- Ke utlwisisa hore ho nka karolo phuputsong ena ke ho etsa **ka boithaopo** mme nna kapa ngwana wa ka ha re a hatellwa ho nka karolo.
- Ha ho ditjeo tse amehang bakeng sa ho nka karolo phuputsong mme ha ho tjhelete e tla fanwa bakeng sa bonkakarolo phuputsong ena.
- Nka nna ka kgetha ho ntsha ngwana wa ka mme ngwana wa ka a ka nna a kgetha ho tswa phuputsong ka nako efe kapa efe mme ha ho letho le lebe le tla etsahala ho nna kapa ngwana wa ka.
- Ngwana wa ka nna a ka kotjwa ho tswa phuputsong pele e fihla pheletsong, haeba mofuputsi a ikutlwa hore ho molemong wa ngwna wa ka ho etsa jwalo, kapa haeba a sa latele morero wa phuputso, jwalo ka ha ke dumetse.

E saennwe (*sebaka*) ....………….... Ka la (*letsatsi*) ………..…………….. 20…...

…………………………………………………………

Tshaeno ya monkakarolo

Appendix L: Principal Information and Consent Form (English)

HEADMASTER/PRINCIPAL OF SCHOOL INFORMATION LEAFLET AND CONSENT FORM

TITLE OF THE RESEARCH PROJECT: Establishing norms for kinesthetic coordination tasks in 6-year-old children in the Mangaung, Motheo District.

REFERENCE NUMBER: (UFS-HSD2020/0143/210)

PRINCIPAL RESEARCHER: Carmen Bonafede

ADDRESS: Department of Exercise & Sport Science

Faculty of Health Sciences

University of the Free State, South Africa

CONTACT NUMBER: 072 466 4665

You are being invited to allow the participation of your school in this research study. Please take some time to read the information presented here, which will explain the details of this study. Please ask anyone involved in this study any questions about any part of this study that you do not fully understand. It is very important that you are fully satisfied, that you clearly understand what this research entails, and how you could be involved. Also, the participation of the school is **entirely voluntary,** and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw your school's consent from the study at any point, even if you initially do agree to take part. The Department of Basic Education provides approval for the study to commence, and you need to provide permission for the research to be done at your school.

This study has been approved by the Health Sciences Research Ethics Committee at the University of the Free State (UFS-HSD2020/0143/210) and will be conducted according to the ethical guidelines and principles of the South African Guidelines for Good Clinical Practice and the Medical Research Council (MRC) Ethical Guidelines for Research.

What is this research study about?

This study aims to set out values that will help us know more about the way in which six-year-old children move their bodies. The study aims to determine the function of their kinesthetic and proprioceptive system, meaning how well they use sensory information coming from inside their bodies, while they do different motor activities. There is currently not a lot of knowledge on norms for kinesthetic coordination tasks for South African children and the researcher would like to gain more information on this important topic. This would enable individuals in practice and in the academic field to know more about the kinesthetic and proprioceptive abilities of children since problems in these children could result in poor academic performance.

Six-year-old children in schools within the Mangaung, Motheo District will be selected to take part in the study. Children's names will not be shown on any of the forms, which mean that information will be kept confidential. Participants will be selected according to their age and consideration will be given to the quintile status of their school. In order to participate in this study, children therefore need to be six years old at the time of data collection.

The children will be asked to do five different tasks, like touching their finger to their nose or balancing. The researcher and trained field workers will first explain to them what to do and how to do the activities. If at any time any of the children do not want to participate anymore, they can just inform the researcher and thereafter they will be excluded from participation. No negative consequences will follow if they do not want to participate anymore.

If the children do not understand what it is that they are supposed to do, a trained interpreter will assist when needed, in order to interpret what is being said to the children. The researcher may ask a teacher or other employee of the involved school to act as an interpreter if permission is given by yourself and the relevant teacher/employee. The interpreter will firstly be trained to explain the activities and they will also be asked to sign a declaration to state that they provide consent to accurately assist the researcher in the research study. They will also be asked to read from a set out script to make sure that task instructions are carried out correctly by the children.

The study will be done at approximately 10 schools in the Mangaung, Motheo District. After the selection of the schools (taking school quintile into account), the first 20 – 40 children (depending on the number selected for the school by the biostatistician) for whom informed consent is obtained will be included in the study sample. It will be stated on the permission documents that even if the parent/guardian of the child receives the information and consent forms and completes and returns the forms in due time, it is not to say that the child is guaranteed participation in this study.

Why have you been invited to participate?

Your school has been selected for participation in this study because it is relatively close to the University of the Free State's main campus, and it falls into the specific school quintile to make the study representative of the South African population.

What will your responsibilities be?

As the principal of the school, we ask that you provide permission for us to conduct the study at your school and allow each selected participant to partake in the set activities for 10 - 15 minutes. The time of the research will be done in a time that is given to us by you as to ensure that it does not affect the children's learning opportunities in any way. The parents of the learner's will also have to provide permission for their child to partake in the study. The children involved will also have to provide assent where after they will physically perform the activities. The researcher therefore also asks for permission to distribute consent forms to the parents, via the school.

Will you benefit from taking part in this research?

You will be helping the researcher and other professionals in child development to gain knowledge on how six-year-old children's bodies move and how they perform different activities. This will also help us know why for example children slouch in their chairs at school or are clumsy when participating in physical activities.

Are there any risks involved in your taking part in this research?

There are no major risks involved in this study. Due to activities being physical of nature it may cause slight physical discomfort or muscle soreness may occur during or after participation. The researcher and field workers do however have Level 1 first aid and will be able to provide care in the unlikely case of any injury that might occur due to the activities or any other factors outside of the researchers' control.

Will you be paid to take part in this study and are there any costs involved?

Participation is voluntary and therefore no one will be paid for their participation in the study. There will be no costs involved for you or the parents.

Is there anything else that you should know or do?

- Know that consent and assent are voluntary and that you as the principal are free to withdraw your school at any time during the study.
- You can contact Carmen Bonafede at 072 466 4665 or Dr Elna de Waal at 051 401 2467 if you have any further queries or encounter any problems.
- You can contact the Health Sciences Research Ethics Committee at the University of the Free State at 051-401 7794/5 if you have any concerns or complaints that have not been adequately addressed.

Declaration by principal (Head of school)

By signing below, I ………………………………….……………. agree to let the following research study take place at my school: ***Establishing norms for kinesthetic coordination tasks in 6-year-old children in the Mangaung, Motheo District***

I declare that:

- I have read this information and consent form and it is written in a language with which I am fluent and comfortable.
- I have had an opprtunity to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I may choose to withdraw consent at any time and will not be penalised or prejudiced in any way.
- I may be asked to withdraw my consent from the study before it has finished, if the researcher feels it is in the best interests of the child, or if the child does not follow the study plan, as agreed to.

Signed at (*place*) ....……………. on (*date*) …………………….. 20...

.. **..**

Signature of principal (Head of school) Signature of witness

Declaration by main researcher

I *(name)* ……………………………………………….......... declare that:

- I explained the information in this document to …………………………………..
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above.
- I did/did not use an interpreter. (*If an interpreter is used then the interpreter must sign the declaration below.*

Signed at (*place*) ....…........………………. on (*date*) …………....……….. 20….

………………………………………………………….	**…………………………………………………..**
Signature of main researcher	Signature of witness

Appendix M: Principal Information and Consent Form (Afrikaans)

INLIGTINGSTUK EN TOESTEMMINGSVORM VIR SKOOLHOOF/PRINSIPAAL

TITEL VAN DIE NAVORSINGSPROJEK: Vasstelling van norme vir kinestetiese koördinasietake by 6-jarige kinders in die Mangaung, Motheo-distrik.

VERWYSINGSNOMMER: UFS-HSD2020/0143/210

HOOFNAVORSER: Carmen Bonafede

ADRES: Departement Oefen- en Sportwetenskappe

Fakulteit Gesondheidswetenskappe

Universiteit van die Vrystaat, Suid-Afrika

KONTAKNOMMER: 072 466 4665

U skool word uitgenooi om deel te neem aan hierdie navorsingstudie. Lees asseblief hierdie inligting wat die besonderhede van die studie verduidelik. Vra asseblief vir enigiemand wat betrokke is by die studie as iets onduidelik is. Dit is baie belangrik dat u heeltemal tevrede is met die inligting, en dat u ten volle verstaan wat hierdie navorsing behels en hoe u betrokke kan wees. Die skool se deelname is **volkome vrywillig** en u mag dit van die hand wys. Indien u nee sê, sal dit geen negatiewe gevolge hê nie. U skool mag enige tyd van die studie onttrek, selfs as u aanvanklik ingestem het om deel te neem. Die Departement van Basiese Onderwys keur die studie goed en u moet toestemming gee dat die navorsing by u skool gedoen word.

Hierdie studie is goedgekeur deur die Gesondheidswetenskappe se Navorsing Etiekkomitee van die Universiteit van die Vrystaat (UFS-HSD2020/0143/210). Dit sal gedoen word volgens die etiese riglyne en beginsels van die Suid Afrikaanse Riglyne vir Goeie Kliniese Praktyk en die Raad vir Mediese Navorsing (RMN) se Etiese Riglyne vir Navorsing.

Waaroor gaan die navorsingstudie?

Hierdie studie beoog om waardes daar te stel wat ons sal help om meer te weet oor hoe ses-jarige kinders hulle liggame beweeg. Die doel van die studie is om die funksie van hulle kinestetiese en proprioptiewe stelsel vas te stel. Dit beteken, hoe goed hulle sensoriese inligting van buite hulle liggame gebruik terwyl hulle verskillende motoriese aktiwiteite uitvoer. Daar is tans nie baie kennis oor norme vir kinestetiese koördinasietake vir Suid-Afrikaanse kinders nie en die navorser wil meer inligting kry oor hierdie belangrike onderwerp. Dit sal praktisyns en akademici meer leer oor die kinestetiese en proprioseptiewe vermoëns van kinders omdat kinders met sulke probleme akademies swak presteer.

Ses-jarige kinders in van die skole in die Mangaung en Motheo-distrik sal gekies word om deel te neem aan die studie. Kinders se name sal nie op enige van die vorms verskyn nie en dus sal inligting vertroulik wees. Deelnemers sal op grond van hul ouderdom gekies word en die kwintielstatus van die skool sal in ag geneem word. Om aan die studie deel te neem moet kinders dus ses jaar oud wees wanneer data ingesamel word.

Die kinders sal vyf verskillende take moet uitvoer, soos om hulle neuse met hul vingers raak of te balanseer. Die navorser en opgeleide veldwerkers sal eers aan hulle verduidelik wat om te doen en hoe om die aktiwiteite te doen. As die kinders op enige stadium nie meer wil deelneem nie, kan hulle net vir die navorser so sê. Daarna sal hulle van die studie uitgesluit word – sonder enige nagevolge.

Indien die kinders nie die opdragte verstaan nie, sal ŉ opgeleide tolk hulle help. Die navorser mag ŉ onderwyser of ander werknemer van die skool vra om as tolk op te tree – indien u en die betrokke onderwyser/werknemer toestemming gee. Die tolk sal eers opgelei word om die aktiwiteite te verduidelik en sal ŉ verklaring teken dat hulp aan die navorser en die navorsingstudie akkuraat sal wees. Die tolk sal ook van ŉ voorbereide dokument aflees om te verseker dat die kinders die instruksies korrek volg.

Die studie sal by ongeveer 10 skole in die Mangaung, Motheo-distrik gedoen word. Nadat skole gekies is (met hulle kwintiele in ag geneem), sal die eerste 20 – 40 kinders gekies word. Die getal kinders in die steekproef word deur die biostatistikus bepaal en hang af van die hoeveelheid kinders wat ingeligte toestemming ontvang. Die toestemmingsdokumente sal meldnoem dat kinders nie noodwendig aan die studie sal deelneem nie – selfs al dien hul ouers/voogde die voltooide toestemmingsvorms betyds in.

Hoekom is u genooi om deel te neem?

U skool is gekies vir die studie omdat dit relatief naby aan die Universiteit van die Vrystaat se hoofkampus is en ook binne die spesifieke kwintiele, wat verteenwoordigend van die Suid-Afrikaanse bevolking is, val.

Wat sal u verantwoordelikhede wees?

As skoolhoof word u versoek om toestemming te gee dat die studie by u skool gedoen word en om vir elke deelnemer 10 – 15 minute te gee om aan sekere aktiwiteite deel te neem. U kan die tyd vir die navorsing bepaal sodat die kinders se onderrigtyd nie benadeel word nie. Die kinders se ouers sal ook moet toestemming gee dat hulle aan die studie deelneem. Die betrokke kinders sal moet toestem om sekere aktiwiteite te doen. Daarom vra die navorser ook toestemming om toestemmingsvorms via die skool onder ouers te versprei.

Sal u voordeel trek uit u deelname aan die navorsing?

U sal die navorser en ander professionele persone betrokke metvan kinderontwikkeling help om kennis in te win oor ses-jariges se liggaamsbeweging en hoe hulle verskillende aktiwiteite uitvoer. Dan kan ons weet hoekom kinders byvoorbeeld nie ’n behoorlike liggaamshouding inneem wanneer hulle op hul stoele in die skool sit nie, of lomp is wanneer hulle aan fisiese aktiwiteite deelneem.

Is daar enige risiko’s verbonde aan deelname aan die navorsing?

Daar is geen groot risiko’s verbonde aan hierdie studie nie. Omdat die aktiwiteite fisiek is, kan geringe fisieke ongemak of seer spiere tydens of na deelname voorkom. Die navorser en die veldwerkers het egter vlak-1 noodhulpopleiding en sal bystand kan bied in die onwaarskynlike geval van beserings of ander faktore buite die navorser se beheer.

Sal u betaal word om deel te neem aan die studie en beloop dit enige onkoste?

Deelname is vrywillig en gevolglik sal niemand betaal word om deel te neem nie. Daar sal geen onkoste vir u of die ouers wees nie.

Is daar enigiets anders wat u moet weet of doen?

- U moet weet dat toestemming vrywillig is en dat u as skoolhoofprinsipaal enige tyd die skool van die studie mag onttrek.
- U kan enige tyd vir Carmen Bonafede by 072 4466 4665 of vir Dr Elna de Waal by 051 401 2467 skakel as u navrae of probleme het.
- U kan die Gesondheidswetenskappe se Navorsingsetiek Komitee van die Universiteit van die Vrystaat by 051-401 7794/5 skakel as enigiets u bekommer of indien klagtes nie genoegsaam gehanteer is nie.

Verklaring deur die skoolhoof/prinsipaal

Deur die onderstaan te teken, gee Ek …………………………………….………… toestemming dat die volgende navorsingstudie by my skool gedoen word: ***Vasstelling van norme vir kinestetiese koördinasie-take by 6-jarige kinders in die Mangaung, Motheo Distrik.***

Ek verklaar dat:

- Ek die inligting en toestemmingsdokument gelees het en dat dit geskryf is in 'n taal waarin ek vlot en gemaklik is.
- Ek 'n geleentheid gehad het om vrae te vra en dat dit voldoende beantwoord is.
- Ek verstaan dat deelname aan hierdie studie **vrywillig** is en dat daar nie druk op my geplaas is om deel te neem nie.
- Ek enige tyd my toestemming mag onttrek en nie gepenaliseer of teen gediskrimineer sal word nie.
- Ek gevra kan word om my toestemming van die studie te onttrek voordat dit eindig as die navorser voel dit is in die beste belang van die kind of indien hy/sy nie die ooreengekome studieplan volg nie.

Geteken te (*plek*) ....………….. op (*datum*) ………………... 20...

....

Handtekening van die skoolhoof/prinsipaal Handtekening van getuie

Verklaring deur die hoofnavorser

Ek *(naam)* …………………………………………..……… verklaar dat:

- Ek die inligting in hierdie dokument verduidelik het aan …………………………………..
- Ek het hom/haar aangemoedig om vrae te vra en het genoeg tyd geneem om dit te beantwoord.
- Ek is tevrede dat hy/sy al die aspekte van die navorsing, soos hierbo bespreek, verstaan.
- Ek het/het nie 'n tolk gebruik (nie). *As 'n tolk gebruik is, moet hy/sy die onderstaande verklaring teken*.

Geteken te (*plek*) ....…………….. op (*datum*) …………..…… 20….

....

Handtekening van hoofnavorser Handtekening van getuie

Appendix N: Principal Information and Consent Form (Sesotho)

PAMPITSHANA YA TLHAHISOLESEDING LE FOROMO YA TUMELO YA MOSUWEHLOOHO

SEHLOOHO SA PROJEKE YA PATLISISO: Ho theha maano bakeng sa kgokahanyo ya ditshebetso tsa motsamao baneng ba dilemo tse 6 ba Mangaung, Seterekeng sa Motheo

NOMORO YA REFERENSE: UFS-HSD2020/0143/210

MOFUPUTSI WA SEHLOOHO: Carmen Bonafede

ATERESE: Department of Exercise & Sport Science

Faculty of Health Sciences

University of the Free State

NOMORO YA BOIKOPANYO: 072 466 4665

O memelwa ho dumella bonkakarolo ba sekolo sa hao phuputsong ena ya boithuto. Ka kopo iphe nako ya ho bala tlhahisoleseding e fanweng mona, e tla hlalosa dintlha tse feletseng ka phuputso ena. Ka kopo botsa mang kapa mang ya amehang phuputsong ena mabapi le karolo efe kapa efe ya phuputso ena eo o sa e utlwisiseng ka botlalo. Ho bohlokwa haholo hore o ikgotsofatse ka botlalo, hore o utlwisisa se hlokwang ke phuputso ena, le ka moo o ka amehang. Hape, bonkakarolo ba sekolo sa hao ke ba **boithaopo ka ho phethahala** mme o na le tokelo ya ho hana ho nka karolo. Haeba o re tjhe, sena se ke ke sa o ama ka tsela e seng ntle jwang kapa jwang. Hape o lokolohile ho ka hula tumelo ya sekolo sa hao phuputsong ka nako efe kapa efe, esita leha one o dumetse qalong ho nka karolo. Lefapha la Thuto ya Motheo le fana ka tumello bakeng sa phuputso ho qala mme o hloka ho fana ka tumello bakeng sa patlisiso ho etswa sekolong sa heno.

Phuputso ena e fuwe tumello ke Komiti ya Boitshwaro ya Dipatlisiso tsa Saense ya Yunifesithi ya Foreistata (UFS-HSD2020/0143/210) **mme e tla etswa ho latela melawana ya boitshwaro le maano a Tshebetso e Ntle ya tsa Bongaka Afrika Borwa le Melawana ya Boitshwaro Tshebetsong ya Lekgotla la Dipatlisiso tsa Bongaka.**

Phuputso ee ya patlisiso hantle e mabapi le eng?

Phuputso ena e rerile ho teka maano a tla re thusa ho tseba haholwanyane mabapi le tsela eo bana ba dilemo tse 6 ba tsamaisang mmele ya bona. Maikemisetso a phuputso ke ho fumana tshebetso ya temoho ya motsamao wa mmele (kinesthetics) le sistimi ya ditlhohleletso tsa kahare ho mmele tsa motsamao (proprioceptive), e leng se bolelang hore na ba sebedisa hantle hakae tlhahisoleseding e tswang dikutlong tsa motho ho tswa kahare ho mmele ya bona, ha ba etsa mesebetsi e fapaneng ya bona ya motsamao. Hajwale ha ho na tsebo e ngata mabapi le ditsebo tse mabapi le ditshebetso tsa kgokahanyo ya motsamao ya mmele bakeng sa bana ba Afrika Borwa mme mofuputsi o lakatsa ho fumana tlhahisoleseding e eketsehileng mabapi le sehlooho sena sa bohlokwa. Sena se tla dumella batho ba tshebetsong le mafapheng a tsa thuso ho tseba haholwanyane mabapi le bokgoni ba "*kinesthetic*" le "*proprioceptive*" ba bana hobane mathata a baneng bana a ka baka tshebetso e mpe dithutong tsa bona.

Bana ba dilemo tse 6 dikolong tse kahare ho Mangaung, Setereke sa Motheo ba tla kgethwa ho nka karolo phuputsong. Mabitso a bana a ke ke a bontshwa diforomong dife kapa dife, e leng se bolelang hore tlhahisoleseding e tla bolokwa sephiring. Bankakarolo ba tla kgethwa ho latela dilemo tsa bona mme tsepamiso ya maikuto e tla fanwa ho boemo ba kabo ya dilemo ho latela mekgahlelo e meng ya sekolo sa bona. E le ho nka karolo phuputsong ena bana ba hloka ho ba dilemo tse tsheletseng ka nako ya ho bokeletswa ha lesedi (datha).

Bana ba tla kotjwa ho etsa dintho tse hlano jwalo ka ho thetsa nko ya bona ka monwana kapa ho ema ka leoto le le leng. Mofuputsi le basebetsi ba setjhabeng ba rupetsweng ba tla qala ka ho ba hlalosetsa seo ba se etsang le ka moo mesebetsi e etswang ka teng. Haeba ka nako efe kapa efe bana ba se ba sa batle ho nka karolo, ba ka tsebisa mofuputsi feela mme kamora moo ba tla ntshuwa bonkakarolong. Ha ho ditlamorao tse mpe tse tla latela haeba ba se ba sa batle ho nka karolo.

Haeba bana ba sa utlwisise hore ke eng seo ba lebeletsweng ho se etsa, mofetoledi wa puo ya rupetsweng o tla thusa ha ho hlokeha, e le ho toloka se jwetswang bana. Mofuputsi a ka nna a kopa titjhere kapa mosebetsi e mong wa sekolong se amehang ho sebetsa jwalo ka mofetoledi wa puo haeba tumello e fanwe ke wena le titjhere/mosebetsi ya amehang. Mofetoledi wa puo o tla qala pele ka ho hlalosa mesebetsi mme hape o tla kotjwa ho saena boikano ho bolela hore o fana ka tumelo bakeng sa ho thusa mofuputsi ka nepo phuputsong ya boithuto. O tla kotjwa ho bala sengolweng se tekilweng ho etsa bonnete ba hore ditaelo di phethahatswa ka nepo ke bana.

Phuputso e tla etswa dikolong tse ka bang 10 tse Mangaung, Seterekeng sa Motheo kamora kgetho ya dikolo (ho etswe hloko kabo ya bana ho latela dihlopha tse nne), bana ba pele ba 20 – 40 (ho ipapisitswe le palo e kgethilweng bakeng sa sekolo ke radipalopalo wa setjhaba) eo tumelo ya hae e fumanweng e tla kenyeletswa sampoleng ya phuputso. Ho tla bolelwa ditokomaneng tsa tumello hore esita leha motswadi/mohlokomedi wa ngwana a fumane tlhahisoleseding le diforomo tsa tumelo mme a kgutlisetsa diforomo ka nako, ha se ho bolela hore ngwana o tiiseditswe bonkakarolo phuputsong ena.

Hobaneng o memilwe ho nka karolo?

Sekolo sa heno se kgethilwe bakeng sa bonkakarolo ba phuputsong ena hobane se haufi le khampase e kgolo ya Yunivesiti ya Foreistata, mme se wela kantle ho karolo ya palo ya bone ya dikolo tse kgethehileng ho fana ka boemedi ba setjhaba sa Afrika Borwa.

Boikarabello ba hao e tla ba bofe?

Jwalo ka mookamedi wa sekolo, re kopa hore o fane ka tumello ya hore re etse phuputso sekolong sa heno ka ho dumella monkakarolo ka mong ya kgethilweng nako ya metsotso e 10 - 15 ho nka karolo mesebetsing e tekilweng. Nako ya patlisiso e tla etswa ka nako e fanweng ho rona ho netefatsa hore ha e ame menyetla ya bana ya ho ithuta ka tsela efe kapa efe. Batswadi ba baithuti hape ba tla fana ka tumello bakeng sa bana ba bona ho nka karolo phuputsong. Bana ba amehang hape ba tla lokela ho dumela ho fana ka tumelo moo ba tla phetha mesebetsi e sebedisang mmele. Bafuputsi ka hona hape ba kopa tumello ya ho aba diforomo tsa tumelo ho batswadi, ka sekolo.

Na o tla fumana molemo ka ho nka karolo patlisisong ee?

O tla be o thusa mofuputsi le baporofeshenale ba bang ba sebetsang ho tsa kgolo ya bana ho fumna tsebo e mabapi le ka moo mmele ya bana ba dilemo tse 6 e tsamayang ka teng le hore ba etsa diketso tse fapaneng jwang. Sena hape se tla re thusa ho tseba hore ke hobaneng, ho etsa mohlala, bana ba dula ba kgohletse kahara ditulo sekolong kapa ha ba etsa mesebetsi e sebedisang mmele.

Na ho na le dikotsi tsa letho tse amehang ka ho nka karolo patlisisong ee?

Ha ho na menyetla ya kotsi e meholo e amehang phuputsong na. Ke lebaka la sebopeho sa mesebetsi e hlokang ho sebedisa mmele ho ka nna ha ba le makukuno a manyane mmeleng kapa mesifa e bohloko e ka nna ya ba teng kamora ho nka karolo. Mofuputsi le basebetsi ba hara setjhaba leha ho le jwalo ba na le maemo a 1 ba thuso ya pele mme ba tla kgona ho fana ka tlhokomelo haeba ka sewelo ho etsahala hore ho be le temalo e ka nnang ya hlaha ka lebaka la mesebetsi kapa dintlha tse ding tse kantle ho taolo ya bafuputsi.

Na o tla nka karolo phuputsong ee mme na ho na le ditjeo tse amehang?

Bonkakarolo ke ba boithaopo mme ka hona ha ho motho ya tla lefuwa bakeng sa bonkakarolo phuputsong. Ho ke ke ha ba le ditjeo tse hlokehang bakeng sa hao kapa batswadi.

Na ho na le eng kapa eng e nngwe eo o lokelang ho e tseba kapa ho e etsa?

- Tseba hore tumelo le tumello di etswa ka boithaopo mme wena jwalo ka mosuwehlooho o lokolohile ho ka hula sekolo sa hao ka nako efe kapa efe ya phuputso.
- O ka ikopanya le Carmen Bonafede ho 072 466 4665 kapa Ngaka Elna de Waal ho 051 401 2467 haeba o na le dipotso tse ding kapa o thulana le mathata afe kapa afe.
- O ka ikopanya le Komiti ya Boitshwaro ya Disaense tsa Dipatlisiso tsa Bophelo (Health Sciences Research Ethics Committee) Yunifesithing ya Foreistata ho 051 051-401

7794/5 haeba o na le dingongoreho dife kapa dife kapa ditletlebo tse sa rarollwang ka tsela e lekaneng.

Boikano ba Mosuwehlooho (Hlooho ya sekolo)

Ka ho saena ka tlase mona, nna ……………………………………..………… ke dumela ho dumella phuputso ya boithuto e latelang ho etswa sekolong sa heso: ***Ho theha maano bakeng sa kgokahanyo ya ditshebetso tsa motsamao baneng ba dilemo tse 6 ba Mangaung, Seterekeng sa Motheo***

Ke ikana hore:

- Ke badile tlhahisoleseding ena le foromo ya tumelo mme e ngotswe ka puo eo ke e tsebang hantle le ho phutholoha ka yona.
- Ke bile le monyetla wa ho botsa dipotso tsohle tsa ka mme di arabilwe ka tsela e lekaneng.
- Ke utlwisisa hore ho nka karolo phuputsong ena ke ho etsa **ka boithaopo** mme ha ke a hatellwa hore ke nke karolo.
- Nka kgetha ho hula tumelo ka nako efe kapa efe mme nke ke ka fuwa kotlo kapa ka kena mathateng ka tsela efe kapa efe.
- Nka nna ka kotjwa ho hula tumelo ya ka pele phuputso e fihla pheletsong, haeba mofuputsi a ikutlwa hore ho le molemo ho etsa jwalo, kapa haeba ke sa latele morero wa phuputso, jwalo ka ha ke dumetse.

E saennwe (*sebaka*) ....…..........…………….. ka la (*letsatsi*) ……….............….. 20...

………………………………………………………. **……………………………………………….…**

Tshaeno ya mosuwehlooho (Hlooho ya sekolo) Tshaeno ya paki

Boikano ya mofuputsi wa sehlooho

Nna *(lebitso)* ……………………………………………….……… ke ikana hore:

- Ke hlalositse tlhahisoleseding e tokomaneng ena ho …………………………………..
- Ke mo kgothaleditse ho botsa dipotso mme ke nkile nako e lekaneng ho di araba.
- Ke kgotsofetse hore o utlwisisa dintlha tsohle tse mabapi le patlisiso ka tsela e lekaneng, jwalo ka ha di hlalositswe ka hodimo mona
- Ke sebedisitse/Ha ke a sebedisa toloko. (*Haeba toloko e sebedisitswe toloko e tlameha ho saena boikano bo ka tlase mona.*

E saennwe (*sebaka*) ....…..........….……….. ka la (*letsatsi*)…………….………. 20…..

..   **..**

Tshaeno ya mofuputsi wa sehlooho   Tshaeno ya paki

Appendix O: South African Journal of Childhood Education

Author Guidelines:

https://sajce.co.za/index.php/sajce/pages/view/submission-guidelines