The performance of five-year-old children from Mangaung Metro on ten subtests of J. Ayres based Clinical Observations

by

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Dissertation submitted in fulfilment of the requirements in respect of the Master’s Degree qualification

M. Occupational Therapy

in the Department of Occupational Therapy in the Faculty of Health Sciences at the University of the Free State, Bloemfontein.

2018

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DECLARATION

I Chané Potgieter, declare that the Master's Degree research dissertation that I herewith submit for the interdisciplinary Master's Degree qualification in Occupational Therapy (interdisciplinary dissertation with Higher Education Studies) 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.

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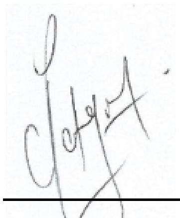

C. Potgieter

ACKNOWLEDGEMENTS

Dear God, I want to take a minute, not to ask anything from you, but simply to say thank you, for all I have.

-Anonymous-

My sincere gratitude towards:

- My study leader Mrs Elize Janse van Rensburg. Elize, you are more than just my study leader, you are my mentor and friend. Thank you for all your wisdom, love, and the kind manner in which you encouraged me. I could not have asked for a better study leader.
- My co-study leader, Mrs Annamarie van Jaarsveld. I stand in awe of your wisdom. I am so grateful that I had the opportunity to learn from you. Your passion for and knowledge of sensory integration is truly inspiring. I sincerely thank you for the diligent assistance through this journey, even though you were busy with your PhD.
- Mr Cornel van Rooyen in the Department Biostatistics at the University of the Free State. Thank you for your assistance and guidance in the data analysis process.
- Mr Eric Lerata from the Skills Unit at the University of the Free State. Eric, I was fortunate enough that you agreed to be my translator, but I am more thankful that I got a friend in the process. I will forever be grateful to you, as the study would not have been possible without your assistance.
- My dearest friend Amor Joubert. Thank you for assisting me in the data collection process. I am truly blessed that we are friends, sharing a passion for sensory integration. I am thankful to have you in my life.
- My husband, Jacques Potgieter. Thank you for your endless love, support and motivation. I am thankful that you encouraged me to enrol for this Master's Degree and that you believed in me. Thank you for your patience with this thesis being part of our lives for the past two years.
- My parents, Dolfie and Corene Potgieter. Thank you for the manner in which you raised me it assisted me to persevere to the end. Your interest in my research, love and kind words is much appreciated.

- My parents-in-law, Phillippe and Lynne Potgieter. Thank you for all your support, assistance and love through this journey.
- My colleagues in the Department of Occupational Therapy at the University of the Free State. Thank you for all the kind, inspiring and encouraging words in the passages.
- The personnel from the Clinical Skills Unit at the University of the Free State, for their selfless sacrifice, allowing Eric to serve as my translator.
- To my friends and family – a special thank you to each one of you. Thank you for your support, love and care. Thank you for the small gestures, hugs and kind words in times I needed it most. And above all, thank you that you assisted me in living a balanced life.
- To all the schools, educators, parents and participants. I am indebted to every one of you.
- Thank you to SAISI, for the financial assistance as well as to the University of the Free State for the Master's Degree bursary.
- Thank you God for your guidance and thank you for blessing me through this journey.

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LIST OF ACRONYMS

ACOs	Ayres Clinical Observations
AL	Anterolateral
APA	American Psychological Association
ASI	Ayres Sensory Integration
ATNR	Asymmetrical Tonic Neck Reflex
CNS	Central Nervous System
COMPS	Clinical Observations of Motor and Postural Skills
COs	Clinical Observations
DCML	Dorsal column-medial lemniscal
DDK	Diadokokinesis
DOE	Department of Education
DTVP	Developmental Test of Visual Perception
EMIS	Educational Management Information System
ER	Equilibrium Reactions
FBR	Flat board reach
FS DOE	Free State Department of Education
FTN	Finger-To-Nose
GS	Gaze Stability
HPCSA	Health Professions Council of South Africa
HSES	High socio-economic status
HSREC	Health Sciences Research Ethics Committee

LSES	Low socio-economic status
OT	Occupational therapy
OTASA	Occupational Therapy Association of South Africa
OTs	Occupational therapist(s)
PEP	Prone Extension Posture
Q_1-Q_3	Quartiles (referring to statistical values)
Q1-Q5	Quintiles (referring to schools)
QNST	Quick Neurological Screening Test
RIP	Reflex Inhibiting Posture
SA	South Africa
SAE	Schilder's Arm Extension
SAISI	South African Institute for Sensory Integration
SAn	South African
SB	Standing Balance
SCSIT	Southern California Sensory Integration Tests
SE	Socio-economic
SES	Socio-economic status
SFP	Supine Flexion Posture
SH	Should have
SI	Sensory Integration
SIPT	Sensory Integration and Praxis Tests
SNH	Should not have
STNR	Symmetrical Tonic Neck Reflex

TBR	Tilt board reach
TFT	Thumb-Finger Touching
TLR	Tonic Labyrinthine Reflex
UFS	University of the Free State
US	United States
VMI	Visual-Motor Integration

CONCEPT CLARIFICATION

To obtain clarity, core concepts related to the study will be defined. Where applicable, relevant literature was consulted to provide definitions of concepts. Concepts are listed alphabetically and cross-referenced.

Activities of daily living (cf. 2.3.2)

"Activities of daily living are those occupational performance tasks that a person does each day to prepare for, or as an adjunct to, role tasks" (Trombly & Quintana, 1989, p. 386) (cf. occupation in concept clarification).

Adaptive response (cf. 2.3.1)

When the process of sensory integration is going well, "the child organizes a successful, goal directed action on the environment, which is called an adaptive response. When a child makes an adaptive response, he or she successfully meets some challenge presented in the environment" (Parham & Mailloux, 2010, p. 327).

Assessment (cf. 2.2.1)

Assessment forms part of the evaluation process and enables the therapist to gather information about the child's performance skills, using a variety of methods (Stewart, 2010, p. 193).

Central nervous system (cf. 2.3.1)

The central nervous system comprises of the brain and spinal cord (Kiernan, 1998, p. 12) and controls and integrates information received from sensory organs to determine the body's response (Guyton, 1976, p. 54).

Cerebellum (cf. 2.4.3 i)

The cerebellum "…is essentially a motor part of the brain, functioning in the maintenance of equilibrium and in the coordination of muscle contractions… The cerebellum ensures that there is contraction of the proper muscles at the appropriate time, each with the correct force" (Kiernan, 1998, p. 196).

Clinical Observations (cf. 2.3.4 and 2.4.1)

Clinical observations "typically involve a set of specific procedures that allow the therapist to observe signs of nervous system integrity that are associated with sensory integrative functioning" (Parham & Mailloux, 2010, p. 352).

Clinical Significance (cf. 5.3.2.2)

Differences between groups can be found to have statistical significance, even though these differences may not be clinically significant. It is important to consider if the difference has practical value (Joubert, 2007, p. 146). "The decision on how large a difference or change is required for it to be clinically meaningful from a public health perceptive is based on knowledge of the subject matter, the question being asked and the users of the information" (Joubert, 2007, p. 147).

Evaluation (cf. 2.2.1)

Evaluation is the fundamental dynamic process of gathering information needed to assist the therapist in identifying goals and plan intervention (Stewart, 2010, pp. 193-194).

Habituation (cf. 2.3.1)

Habituation can be described as the ability to filter out sensory information from the environment (Case-Smith, 2010, p. 67).

Measurable characteristics (cf. 3.2.1 and 3.2.4.1)

This refers to all the characteristics of a child's performance on an item that was measured with a numerical value. Numerical values included a grade score allocation (between 1 and 5) on a rating scale which was based on the overall performance of the participant on a specific item. In addition, it included the number of repetitions in a movement pattern, duration in seconds to maintain a posture and/or degree of postural changes relevant to the item being tested.

Observable characteristics (cf. 3.2.1 and 3.2.4.1)

Refers to *how* the child performs the action (intensity, the positioning of body parts, associated reactions etc.). The observable characteristics consisted of 'should have' and 'should not have' parameters.

Occupation (cf. 2.3.1)

In the occupational therapy practice framework, the term "refers to the daily life activities in which people engage. Occupations occur in context and are influenced by the interplay among client factors, performance skills, and performance patterns. Occupations occur over time; have purpose, meaning, and perceived utility to the client. Occupations can involve the execution of multiple activities for completion and can result in various outcomes." (American Occupational Therapy Association, 2014, p. 6). Occupation comprises off "…activities of daily living (ADLs), instrumental activities of daily living (IADLs), rest and sleep, education, work, play, leisure, and social participation" (American Occupational Therapy Association, 2014, p. 6).

Children's occupations include activities of daily living such as self-care (e.g. washing, getting dressed, using the toilet, drinking and eating), recreational activities and play (e.g. games, sports and socialising with friends) and school engagement (Luebben, Hinojosa, & Kramer, 2010, pp. 35-38).

Occupational performance (cf. 2.2.1)

"Occupational performance is the accomplishment of the selected occupation resulting from the dynamic transaction among the client, the context and environment, and the activity or occupation" (American Occupational Therapy Association, 2014, p. 14).

Performance indicators (cf. 2.4.2)

Performance indicators refer to the measurable and/or observable characteristics of a child.

Praxis (cf. 2.3.1)

Praxis, also referred to as motor planning by some, is the "highest and most complex form of functioning in children. It depends upon very complex sensory integration throughout the brain stem and cerebral hemispheres. The brain tells the muscles what to do, but the sensations from the body enable the brain to do the telling. Motor planning is the bridge between the sensorimotor and the intellectual aspects of brain functioning" (Ayres A. J., 2005, p. 90).

Sensory Integration

The term 'sensory integration' can be used in different contexts. "In some contexts, it is used to refer to a particular way of viewing the neural organisation of sensory information for functional behaviour" (Parham & Mailloux, 2010, p. 325). In this context, it is defined by Ayres as the "organization of sensation for use" (Ayres, 2005, p. 5). **(cf. 2.3.1)**

In other situations, this term refers to a clinical frame of reference for the assessment and treatment of people who have functional disorders in sensory processing (Parham & Mailloux, 2010, p. 325). **(cf. 2.2.1)**

Standardised tests (cf. 2.2.1)

Standardised test "means that examiners must use the same instructions, materials and procedures each time they administer the test, and they must score the test using criteria specified in the test manual… Standardised tests provide precise measurements of a child's performance in specific areas" (Richardson, 2010, p. 216).

Theoretical frame of reference (cf. 1.1 and 2.2.1)

"Frames of references are based on one or more theories… In the pediatric arena, the frame of reference offers an outline of fundamental theoretical concepts relative to particular areas of function. The frame of reference serves as a guideline for assessing functional capacities in a client and offers a method for conceptualizing and initiating intervention. Frames of reference, therefore, enable the therapist to use theory in practice" (Hinojosa, Kramer, & Luebben, 2010, p. 6).

Statistical significance (cf. 4.1)

Statistical significance implies that the comparison of two groups on statistical tests such as the t-test, shows a significant difference between the groups, with a *p*-value of less than 0.05 (Polit & Beck, 2006, pp. 73, 370). This is calculated on a 95% level of confidence.

SUMMARY AND KEY TERMS

Key terms: Clinical Observations, paediatrics, assessment, sensory integration, five-year-old children, socio-economic status.

Introduction: South African (SAn) occupational therapists (OTs) are increasingly confronted with children experiencing sensory integration (SI) difficulties. A wide variety of SI assessment measures are available from which Clinical Observations (COs), originally developed by Ayres, are used widely amongst SAn OTs to support their reasoning on possible dysfunction/s in SI. The COs assist the therapist in distinguishing typical from possible atypical performance. The COs are a cost and time effective measuring instrument, widely used amongst SAn OTs. In addition, in under-resourced communities, the COs are often relied on for assessment as funding is not available for the use of standardised tests. Limited research has, however, been done on the use of the COs on SAn children, describing age-related performance.

Purpose: The purpose of the study was to investigate the performance of five-year-old children from Mangaung Metro on ten subtests of J. Ayres based Clinical Observations. This allowed the researcher to gain descriptive observations to assist the therapist in distinguishing typical from atypical performance more clearly.

Methodology: A descriptive observational study design along with a cross-sectional study design was used. One hundred and twenty (120) participants from both genders, aged between five years six months and five years eleven months, adhering to specific inclusion criteria, and from diverse socio-economic status, were assessed at eight public pre-schools located in Bloemfontein. An adapted COs measuring instrument was used. The measuring instrument comprised of measurable characteristics that included quantitative data (e.g. overall grade score and number of repetitions in a movement pattern), and observable characteristics. The observable characteristics were grouped according to performance thought to be desirable, i.e. 'should have' (SH) parameters, and performance thought to be undesirable in the performance of the COs items, i.e. 'should not have' (SNH) parameters.

The participants were assessed individually and video recorded to allow for detailed analysis. The participants were firstly scored *in vivo*, whereafter the researcher re-assessed each video recording to compare the findings with the initial assessment. The results were analysed by the Department of Biostatistics at the University of the Free State.

Findings: The five-year-old children in this study performed similarly to the currently used norms on most of the items. These items can, therefore, be used in assessment to identify areas of possible difficulty. However, a high incidence of possible un-integrated primitive postural reflexes was found in the study population. The results for the observable characteristics (SH and SNH parameters) were categorised according to prevalence criteria. The results showed several COs' SH parameters were not always present and several SNH parameters were present in the execution of the COs items. In terms of comparing socio-economic groups, performance was similar in both groups across most test items. Two subtests did, however, have clinically significant differences on the measurable characteristics. Isolated differences on the observable characteristics were evident in most of the COs items, with clinically significant differences found in six of the COs items.

Conclusion: The study revealed typical age expected performance of a group of five-year-old children in South Africa on ten selected COs items. It is a reasonable expectation that typically developing children from this age group, would be able to adequately perform most of the items and the inability to do so might be suggestive of possible difficulty. The data will allow OTs to interpret an observed performance on ten items of the COs more accurately, as in-depth observations became evident through this study.

Word count: 565

OPSOMMING EN SLEUTELTERME

Sleutelterme: Kliniese Observasies, pediatrie, sensoriese integrasie, vyfjarige kinders, sosio-ekonomiese status.

Inleiding: In Suid-Afrika word arbeidsterapeute gereeld gekonfronteer met kinders wat sensoriese integrasie (SI) uitdagings ervaar. ‘n Verskeidenheid assesseringsinstrumente is beskikbaar om SI disfunksies te identifiseer, onder andere kliniese observasies (KOs), oorspronklik ontwikkel deur Ayres, wat die terapeut ondersteun tydens die kliniese beredeneringsproses. Die KOs stel ‘n terapeut in staat om tipiese en a-tipiese gedrag van mekaar te onderskei. Die KOs is ‘n koste- en tydseffektiewe assesseringsinstrument en word gereeld gebruik deur Suid-Afrikaanse arbeidsterapeute. Daarbenewens maak terapeute in minder bevoorregte gemeenskappe staat op observasies om sensoriese uitdagings te identifiseer, aangesien finansies en hulpbronne beperk is. Ongelukkig is daar beperkte navorsing op die gebruik van die KOs, asook beskrywing van tipiese deelname van Suid-Afrikaanse kinders op die KOs.

Doel: Die doel van die studie was om ondersoek in te stel oor die deelname van vyfjarige kinders van Mangaung Metro op tien subtoetse van die J. Ayres gebaseerde KOs. Dit het die navorser in staat gestel om beskrywende deelname van vyfjarige kinders te verkry, wat terapeute kan gebruik om tipiese en a-tipiese deelname van mekaar te kan onderskei.

Metodologie: ‘n Beskrywende, waarnemingstudie, tesame met ‘n deursnee-studie ontwerp is gebruik. Honderd-en-twintig (120) tipiese ontwikkelde kinders van beide geslagte, tussen die ouderdom vyf jaar ses maande en vyf jaar elf maande, onderhewig aan ‘n spesifieke insluitingskriteria, van ‘n diverse sosio-ekonomiese status is ingesluit in die studie. Die kinders is geassesseer by agt skole in Bloemfontein, met die hulp van ‘n aangepaste KOs assesseringsinstrument. Die instrument het beide meetbare (bv. algehele telling en aantal bewegingspatrone) en waarnemingsgerigte eienskappe ingesluit. Die waarnemingsgerigte eienskappe het bestaan uit wenslike eienskappe (eienskappe wat verwag word om teenwoordig te wees) en nie-wenslike eienskappe (eienskappe wat verwag word om nie teenwoordig te wees tydens deelname aan die KOs nie).

Die deelnemers is individueel geassesseer en ‘n video van die deelname is gemaak vir gedetailleerde analise van die deelname. Die deelnemers is eers *in vivo* geassesseer. Die navorser het na afloop van die assessering die video opnames bestudeer en die bevindinge is met mekaar vergelyk. Die resultate is geanaliseer deur die Department Biostatistiek by die Universiteit van die Vrystaat.

Resultate: Die vyf jarige kinders in die studie het soortgelyk presteer in vergelyking met die huidige norms op die meeste items. Die subtoetse kan dus gebruik word in die assessering van vyfjarige kinders om areas van moontlike uitdagings te identifiseer. Daar was wel een subtoets, primitiewe reflekse, waar die kinders beduidend swakker presteer het, en dit is aanduidend dat ‘n groot aantal van die studiepopulasie se reflekse moontlik nie geïntegreer is nie. Die resultate van die waarnemingsgerigte eienskappe (beide gewenste en nie gewenste eienskappe) is gekategoriseer volgens voorkoms kriteria. Die resultate het bevind dat sommige wenslike eienskappe nie altyd teenwoordig is nie en sommige nie-wenslike eienskappe wel teenwoordig kan wees in die tipiese vyfjarige populasie. Beide sosio-ekonomiese groepe het soortgelyk presteer in die meeste van die subtoetse. Twee subtoetse het wel kliniese beduidende verskille getoon op die meetbare eienskappe van die KOs. Geïsoleerde verskille op die waarnemingsgerigte eienskappe in die meeste van die subtoetse het voorgekom, maar daar was wel ses subtoetse wat klinies beduidende verskille getoon het.

Gevolgtrekking: Die studie het tipiese verwagte ouderdomstoepaslike gedrag in ‘n groep vyfjarige kinders in Suid-Afrika bekendgemaak. Dit is ‘n realistiese verwagting dat tipiese vyfjarige kinders gemiddeld sal presteer op die meeste van die KOs subtoetse, en die onvermoë om tipies te presteer kan aanduidend wees van moontlike uitdagings. Die data sal arbeidsterapeute in staat stel om observasies vanuit die KOs meer akkuraat te interpreteer, aangesien in-diepte observasies deur die studie verkry is.

Woord telling: 586

CHAPTER 1

Introduction and orientation

1.1 Introduction

> *A science is marked by the quality and degree to which it measures the parameters of its field. Measuring instruments are critical tools for acquiring knowledge and it is difficult to acquire knowledge without them. The more precisely behaviour is measured the better it is understood* (Ayres in Mailloux, 1990, p. 589).

The theory of sensory integration (SI) is regarded as the most developed and researched theory in occupational therapy (OT) (Mulligan, 2002, p. 397). In 2007 the term Ayres Sensory Integration (ASI®) was trademarked to distinguish it from other sensory-based approaches (Smith Roley, Mailloux, & Glennon, 2007).

SI is often used as a frame of reference by occupational therapists (OTs) in South Africa (SA), guiding both assessment and intervention for use within the South African (SAn) paediatric population (Van Jaarsveld, Venter, Joubert, & Van Vuuren, 2001 and Van Jaarsveld, Mailloux, & Herzberg, 2012). It is, therefore, imperative for paediatric OTs to conduct accurate assessment and relevant treatment of children with SI difficulties (Van Jaarsveld, Mailloux, Smith Roley, & Raubenheimer, 2014, p. 2). One challenge, however, is that much of the available SI research, including standardised test development and standardisation, was done on children residing primarily in the United States (US). As the context of SA differs from the US, the findings are not always transferable to the SAn context. This can be supported by research done by Van Jaarsveld et al. (2012), as they questioned the fairness and justness of using the Sensory Integration and Praxis Test (SIPT) on SAn children, due to the standardisation done on a sample of children residing in the US and Canada. They found SAn children performed better on five of the 17 tests of the SIPT and recommended that the primary scores of these five tests be adjusted with half a standard deviation to the negative side when using the SIPT on a SAn population. This highlights the need for SI research within the context of SA, as emphasised by Van Jaarsveld and colleagues (Van Jaarsveld et al., 2014).

The SIPT is the “gold standard for assessing” SI, as the test “is meant to serve primarily as a diagnostic and descriptive tool” and should be supplemented by Clinical Observations (COs) (Ayres, 1989) originally developed by Ayres, referred to as Ayres Clinical Observations (ACOs). This test assists the therapist in distinguishing typical behavioural patterns from immature behavioural patterns (Dunn, 1981, p. V). Over the years, the ACOs have been studied by many researchers (Johnson 1977 in Wilson, Pollock, Kaplan, Law, & Faris, 1992; Dunn, 1981; Harris, 1981; Parmenter, 1983; Gregory-Flock & Yerxa, 1984; Bowman & Katz, 1984; Blanche, 2002 and SAISI, 2005). The ACOs provide therapists with valuable information to support the findings of the SIPT in order to make a conclusion about the child’s SI functions/dysfunctions (Blanche, 2002, p. 9). The ACOs thus form an indispensable part of the SI assessment process, necessitating critical engagement with the research done on ACOs in OT.

As SA has a diverse socio-economic status (SES), OTs are often confronted with children from deprived environments in need of assessment and intervention. A previous study has identified children from deprived environments to be at risk of SI difficulties (Van Jaarsveld, 2010, p. 13). The reality, however, is that limited funding is available for expensive assessment measures such as the SIPT to identify SI problems. Therefore, therapists have to make use of more cost-effective assessment measures to gather information about a child’s SI functions. Often therapists only have their observations from which to draw conclusions and plan interventions accordingly (Van Jaarsveld, 2016).

The currently used ACOs in SA was adapted from the original ACOs by the South African Institute for Sensory Integration (SAISI). The ACOs was published as a booklet, further referred to as COs (SAISI, 2005). However, while the COs were adapted and compiled locally, the researcher has identified three primary reasons to scrutinise the performance of five-year-old SAn children on the COs (SAISI, 2005).

Firstly, the norms used in the interpretation section of the COs (SAISI, 2005) are primarily based on research done outside of SA. Several studies have demonstrated differences between the performance of five-year-old children from SA to those from the US, finding inconsistencies in both perceptual and SI processing (Visser, Cronjé, Kemp, Scholtz, Van Rooyen, & Nel, 2012; Van Jaarsveld, Bartle, de Clerq, Middelcote, Möller, Mostert, Pretorius, Van den Heever, Vlok, 2013; Janse van Rensburg, Strauss, Greyling, Lubbe, Lambrecht, Prinsloo, Vermeulen, Van der Westhuizen, 2013 and Smith, 2015) (cf. 2.2.2). Nonetheless, OTs are using and comparing SAn children to norms researched on children residing primarily in the US when using the COs (SAISI, 2005).

Secondly, as the ACOs' objectives are to assist the therapist in distinguishing typical from atypical behavioural patterns, knowledge must first be gained as to what the typical behavioural patterns are for a child. Up to this point, no research is available as to what the typical expected behaviour is of a five-year-old child engaging in the COs (SAISI, 2005). Five-year-old children were chosen as the focus of the study, as they are in the preparations phase for attending formal schooling and early identification of problem areas through assessment will contribute to early intervention and/or recommendations (Case-Smith, 2010b, pp. 74-75). Grade R learners also make up a large part of OTs' client population as found by Janse van Rensburg, Visser, Johnson, Rawlins, Smith, Janse van Rensburg and Van Greunen (2017).

Thus, the behaviour seen during the COs (SAISI, 2005) are interpreted and used to supplement the SIPT test, without always knowing the relevant expected age-related performance of the child being tested. Norwood (1999, p. 86) supports this predicament as "…therapists may not be sure if they have measured dysfunction or normal sensory integration reliably… when they administer Ayres' Observations", emphasising the need for more accurate and precise knowledge on the age-related performance of five-year-old children on the COs (SAISI, 2005).

Lastly, the COs (SAISI, 2005) is used on five-year-old children from diverse socio-economic (SE) environments, even though research highlights the influence of the SE environment on the child's development (Grantham-McGregor, Cheung, Cueto, Glewwe, Richter, & Strupp, 2007, pp. 60-61), and specifically with regard to SI functioning (Van Jaarsveld, 2010, p. 8). At present, the COs (SAISI, 2005) are administered, interpreted and compared to US norms, regardless of the five-year-old child's SE environment. Considering the afore-mentioned, a third problem arises, namely: what is the difference in the performance on the COs (SAISI, 2005) of five-year-old children, from diverse backgrounds?

1.2 Problem statement

OTs are obligated to honour the "core ethical values and standards for good practice" as outlined by the Health Professions Council of South Africa (HPCSA) (Health Professions Council of South Africa, 2008, p. 2), to "act in the best interests of patients and that includes the use of assessment instruments that have been proven to be fair and just, to the diverse population of SA children" (Van Jaarsveld et al., 2012, p. 12).

The problem, however, is that the COs is an assessment tool that originated from the US, and limited research has been done on the currently used COs (SAISI, 2005) in the SAn context on the performance of five-year-old children from diverse SE environments. This impacts negatively on the fairness and accuracy with which the COs (SAISI, 2005) can be reasoned on, interpreted and used for planning intervention with five-year-old SAn children.

The research was limited to ten COs items (SAISI, 2005) due to the feasibility of the research study. Even though funding was made available, it was limited, and the researcher had restricted time available to test the research population.

As a result, the research question arose: **What is the performance of five-year-old children from Mangaung Metro on ten subtests of the current Clinical Observation adapted by SAISI and based on the work of Jean Ayres?**

1.3 Aim and objectives of the study

The study aimed to describe the performance of children aged five years six months to five years eleven months, from Mangaung Metro on ten subtests of the Clinical Observation based on the work of Jean Ayres.

In order to achieve the main aim, the following objectives were set:

- To describe the measurable characteristics of five-year-old SAn children's performance on the ten COs subtests.
- To describe the observable characteristics of five-year-old SAn children's performance on the ten COs subtests.
- To compare the performance of five-year-old SAn children enrolled in lower and middle to high SE schools on the ten COs subtests.

1.4 Methodology

A quantitative, descriptive, observational study design was used to describe the performance of five-year-old children while executing the ten selected COs items. A descriptive study design "is crafted to gain more information about characteristics within a particular field of study… to provide a picture of situations as they naturally happen" (Burns & Grove, 2009, p. 237). The descriptive observational study design made it possible for the researcher to individually observe the typical performance of five-year-old children, and consequently to identify specific performance characteristics present in the five-year-old population while engaging in the ten COs items. This allowed the researcher to investigate objectives one and two.

Measurable characteristics were obtained through an overall grade score allocation and where applicable, numerical data concerning the duration in seconds, number of repetitions in movement patterns and degree of flexion present in the respective COs item, were obtained. *Observable characteristics* were obtained by recording 'should have' (SH) and 'should not have' (SNH) parameters on the measuring instrument, as they occurred during the child's performance on the COs items (cf. Appendix G and L).

To investigate objective three, a cross-sectional study design was utilised (Burns & Grove, 2009, p. 241). The participants were grouped according to their school's SES, and the performance of the two groups was compared.

The researcher approached schools that were randomly selected through stratified random sampling (Burns & Grove, 2009, p. 350) to obtain consent for inclusion in the study. After obtaining permission from the school principals and parents (cf. 3.2.3), the researcher selected the participants (cf. 3.2.3 b), and the process of data collection started.

The researcher, with the help of a research assistant, tested a total number of 120 typically developing children from diverse SES, in a room provided by the personnel, at the different selected schools, with the assistance of a translator in cases where the children did not understand Afrikaans or English (cf. 3.2.4.2 a). The researcher made use of structured observations through the use of an adapted COs measuring tool (cf. Appendix G).

Each child was video-recorded to allow for detailed analysis (cf. 3.2.4.2), as the researcher re-assessed each child's performance afterwards using the video recordings (cf. 3.2.4.2 e). The findings were transferred to a data scoring document (cf. Appendix K) drafted by the researcher on Microsoft Excel. The researcher checked the data, captured and compared it with the child's COs to ensure accuracy, whereafter a copy of the spreadsheet was submitted electronically to the Department of Biostatistics at the University of the Free State (UFS), for analyses.

Chapter 3 provides detailed information on the study population, sampling method, measuring instrument, data collection process, measurement errors and ethical considerations applied during the study.

1.5 Value of the study

The study can make a positive contribution to the field of OT on three levels:

1) A lack of updated COs related literature was identified, and the study can contribute to expanding the available literature,
2) The study can contribute to the profession's body of knowledge when using the COs as an assessment measure on five-year-old children within the SAn context,
3) The study contributes to the development of the COs measuring instrument itself through, for example, the identification of observations (SH and SNH parameters) for the various COs items included in the study.

The three levels are described in detail in Chapter 6 (cf. 6.4).

1.6 Ethical considerations

The researcher obtained approval from the Health Sciences Research Ethics Committee (HSREC) from the UFS (164/2016), where-after approval from Free State Department of Education (FS DOE) was obtained (cf. Appendix A).

All parties involved in the study: schools, parents, children and the translator, were provided with an information document, consent and/or assent forms, which were all available in Afrikaans, English and Sesotho (cf. Appendix B-E).

Ethical considerations applied to this study during the planning, pre-execution, execution and post-execution phases as well as during the writing of the dissertation, are described in detail in Chapter 3 (cf. 3.3).

1.7 Style of dissertation and chapter outline

The ‘American Psychological Association’ (APA) style of referencing as automated by the *MS Word* Reference Manager, was used throughout this dissertation. The researcher gave credit to authors by providing page numbers both where authors were cited directly and when paraphrased to ease tracking of references. All abbreviations were written out in full when used for the first time in each chapter, whereafter only the abbreviations were used.

The Chapters were organised as follows:

Chapter 1 includes an introduction, with a brief overview of the literature related to the study, followed by the problem statement. The aim and objectives, a summary of the methodology, the value of the study and the ethical considerations are delineated in this chapter, and it ends with a final summary.

Chapter 2 includes a comprehensive literature review. The topics covered in the literature review are depicted on the first page of Chapter 2. A wide variety of literature sources, comprising of books and electronic searches on several databases including MEDLINE®, CINAHL®, EBSCOhost® and Google Scholar®, inside as well as outside the field of OT, were utilised by the researcher to gather a sufficient understanding of the literature related to this study.

Pertaining to the literature consulted, the researcher is aware of the fact that literature used in this dissertation is in many instances relatively old. The latest available literature was always sought, and older sources were only used in the absence of more updated studies, or in cases where primary sources had to be referenced.

Chapter 3 contains a detailed account of the study’s research approach and method of research. The method of research with regard to the study design, study population, sampling method, measurement instrument, data collection and methodological errors are described. A thorough discussion on the ethical considerations applied in the study concludes Chapter 3.

Chapter 4 covers the research results. The chapter is introduced, providing an orientation towards the editorial sequence of the chapter. The results of each COs item are described according to the measurable characteristics, observable characteristics and SE differences that were present. The results are mainly depicted by means of tables.

Chapter 5 discusses, interprets and compares the research results with relevant literature. The chapter is introduced, providing an orientation of the layout and structure of the discussion, followed by an explanation, clarifying the overall handling of the discussion with regard to the measurable characteristics, observable characteristics and SE differences with regard to the ten selected COs items. Each section is critically analysed, and the chapter is concluded with a summary.

Chapter 6 provides an introduction to the layout of the chapter with a revisit to the context and purpose of the study. A final conclusion is drawn to answer the research question and objectives set for this study. The contribution and value of the study to the existing body of knowledge and recommendations for practice and future research are offered. The limitations of the research are presented, and the chapter is ended with a closure.

1.8 Summary

In this chapter, the researcher gave a brief overview and framework of the dissertation. The introduction served to recognise gaps in literature, the most prominent of which are that the performance of five-year-old SAn children on the COs has not been researched previously. Departing from the afore-mentioned, the researcher argued the problem statement, aim and objectives of the study, the purpose of the research and the methodology employed in the study.

A comprehensive literature review is imperative to gain meaningful theoretical perspectives to guide the study. The following chapter provides literature related to assessment measures in paediatric OT, SI theory, COs as a measuring tool and the context of SA.

CHAPTER 2

Literature study

2.1 Introduction

The development and execution of a study is directed through reviewing literature (Burns & Grove, 2009, p. 90). A comprehensive literature study was imperative and served three purposes, namely to (1) orientate the researcher towards the current available knowledge and the gaps therein to support the research question, (2) provide background on key concepts related to the study, and (3) demonstrate an understanding of the literature. The layout of the literature that will be discussed in this chapter is depicted in Figure 2.1.

2.2 Section A: Assessment in the occupational therapy process

2.2.1 Introduction to assessment in occupational therapy

2.2.2 Discrepancies in assessment

2.3 Section B: Sensory integration

2.3.1 Introduction to sensory integration and sensory processing

2.3.2 Development of the five-year-old child

2.3.3 Sensory Integration Dysfunctions

2.3.4 Assessment of sensory integration

2.4 Section C: Clinical Observations

2.4.1 Clinical Observations: A historical perceptive

2.4.2 Development and research in South Africa

2.4.3 Ten chosen subtests

2.4.4 Concluding the COs

2.5 Section D: The South African research context

2.5.1 Context and early childhood

2.5.2 Context and influence thereof on occupational performance

2.5.3 Concluding the literature review

Figure 2.1 Layout of literature review (compiled by the researcher).

2.2 Section A: Assessment in the occupational therapy process

2.2.1 Introduction to assessment in occupational therapy

In occupational therapy (OT), “the evaluation process is one of the most fundamental, yet complex aspects of the profession” and enables the therapist “…to gather information needed to make decisions about intervention services” (Stewart, 2010, pp. 193-194). The evaluation is a dynamic process, starting when the child is referred up until the time when the child is discharged from therapy (Stewart, 2010, p. 194).

In the evaluation process, the therapist must first analyse how the environment influences the child’s occupation, where after “the therapist assesses the child’s performance skills and performance patterns essential to his or her participation in everyday activities” (Stewart, 2010, p. 193).

In the OT process, assessment is a necessity and has four objectives as described by Stewart (2010, pp. 194-199). It assists in establishing goals and planning intervention, determining if a comprehensive evaluation is needed during screening, supports or refutes a possible diagnosis, and measures the efficiency of intervention.

In paediatric OT practice, numerous assessment tools are available to evaluate a child. The choice of which instrument to use is subject to the presenting problems and occupational performance difficulties (Brown, Brown, & Roever, 2006, p. 155). An evaluation plan needs to be formulated to assist the therapist in deciding what types of assessment will best identify the child’s occupational performance difficulties. The plan is based on seven factors, namely: the reasons for referral, history including medical and educational, the child’s chronological age, the theoretical frame of reference, the reason for evaluation, the child’s functional skills, time and current resources available (Stewart, 2010, pp. 200-202). After considering these, an occupational profile is developed, wherefrom a suitable approach, either neurodevelopmental, visual-perceptual, or sensory integration (SI) is used with measuring tools, ranging from standardised assessment, skilled observations and interviews, to guide the assessment (Stewart, 2010, pp. 206-215).

A variety of assessment tools are available to the OT in paediatric practice. Brown et al. (2006, p. 105) compiled a table (see Table 2.1) summarizing studies done on the use of assessment tools in paediatric OT in several different countries. From the findings, it is evident that perceptual, and motor evaluations with the use of standardised tests such as the Developmental Test of Visual-Motor Integration (VMI), Developmental Test of Visual Perception (DTVP), Motor Free Visual Perception Test (MVPT) and Bruininks-Oseretsky Test of Motor Proficiency (BOTMP) are used most frequently. Sensory-based evaluation assessment methods were in the minority and were only identified by Reid (1987) using the Southern California Sensory Integration Test (SCSIT), Rodger (1994) using the Ayres Clinical Observation (ACOs) and Watling et al. (1999) using the Informal Sensory Processing History (ISPH) as well as ACOs (all as cited in Brown et al., 2006, p. 105).

Table 2.1: Paediatric assessment (adapted from Brown et al., 2006, p. 105).

Researchers	Study sample	Country	Method of testing	Tests frequently used
Reid (1987)	69	Canada	Survey	VMI, SCSIT, BOTMP, DTVP, MVPT
Crowe (1989)	293	US	Survey	PDMS, BOTMP, MVPT, VMI
Rodger (1994)	60	Australia	Survey	RGDS, VMI, TVPS, BOTMP, EDPA, MVPT, ACO, MAP
Wallen and Walker (1995)	30	Australia	Survey	VMI, BOTMP, MVPT, TVPS
Watling et al. (1999)	72	US	Survey	ISPH, SP, ACO, PDMS
Feder et al. (2000)		Canada	Survey	VMI, BOTMP, TVPS
Burtner et al. (2002)	301	US	Survey	PDMS, BOTMP, MVPT, VMI, TVPS, TVMS
Howard (2002)	212	UK	Survey	MABC, VMI, TVPS, MVPT, BOTMP, GHDT, MAP, DTVP-2

<u>Abbreviations:</u>
ACO = Ayres' Clinical Observations, BOTMP= Bruininks-Oseretsky Test of Motor Proficiency, DTVP/DTVP-2 = Frostig's Developmental Test of Visual Perception/Developmental Test of Visual Perception 2, EDPA= Erhardt Developmental Prehension Assessment, GHDT= Goodenough-Harris Drawing Test, ISPH= Informal Sensory Processing History, MABC= Movement Assessment Battery for Children, MAP= Miller Assessment for Preschoolers, MVPT= Motor Free Visual Perception Test, PDMS= Peabody Developmental Motor Scales, RGDS= Revised Geseli Developmental Schedules, SCSIT= Southern California Sensory Integration Tests, SP= Sensory Profile, TVMS= Test of Visual Motor Skills, TVPS= Test of Visual Perceptual Skills, VMI= Developmental Test of Visual-Motor Integration.

This article, however, was published in 2006, with 2002 being the last reference used. Research on assessment measures, specifically sensory assessment tools, has since evolved. Research done by Diamantis (2006, p. 284), found sensory assessment measures such as the Sensory Integration and Praxis Test (SIPT) and Sensory Profile (SP) are used amongst occupational therapists (OTs) working in the United Kingdom. In addition, a recent "evaluation tool survey" done in the United States (US), also found sensory assessment measures such as the SIPT, SP and Sensory Processing Measure (Your Therapy Source, 2016) often used by OTs (although this is not an academic source).

An undergraduate study done by Janse van Rensburg et al. (2017) investigated the assessment measures used by 123 South African (SAn) paediatric OTs. Of the participants, 31 worked in the public sector, and 92 worked in the private sector. The assessment instruments used by more than 40% of participants in this study are portrayed in Table 2.2.

Table 2.2: Assessment measures used by SAn paediatric OTs (compiled from Janse van Rensburg et al., 2017).

Assessment	Tests	Frequency (%)
Standardised	Developmental Test of Visual-Motor Integration	95.90
	Goodenough-Harris Draw-a-person	85.30
	Developmental Test of Visual Perception, Second Edition	80.30
	Test of Visual Perceptual Skills, Third Edition	72.10
	Sensory Profile	61.00
	Sensory Integration and Praxis Tests (SIPT)	41.80
Non-Standardised	Ayres Clinical Observations	98.40
	Gross Motor Clinical Observations	81.20

The results of the use of standardised assessment measures indicated the Developmental Test of Visual-Motor Integration (VMI) as the most frequently used assessment tool with usage of 95.90%, which is similar to findings of international studies cited by Brown et al. (2006). With regard to SI assessment, the SIPT was used by only 41.80% of participants. The high costs involved in administering the SIPT relative to other assessment instruments are thought to be one of the reasons that it is not used as frequently as other tests (Janse van Rensburg et al., 2017). With the non-standardised assessment measures, the Clinical Observations (COs) obtained the highest usage percentage of all the assessment measures used by SAn OTs, as 98.40% of therapists reported using the COs during assessment (Janse van Rensburg et al., 2017). The results of the study confirmed the relevancy of the COs to OTs in both private and public sectors in South Africa (SA), highlighting the need for scrutiny on this assessment measure.

It was evident from the results of the study done by Janse van Rensburg et al. (2017) that SAn OTs give preference to standardised assessment measures that originated and were standardised on US samples. The fairness is questioned, as SAn children are compared to normative data outside of their context, regardless of several studies indicating differences in the performance of SAn and US children, on standardised tests.

2.2.2 Discrepancies in assessment

Several studies have examined the appropriateness and use of tests that were standardised in the US, on SAn children, and there seems to be ample evidence of discrepancies in the performance of children from different countries.

Studies done by Linge and Cameron (1986) and Rousseau (1996) on the Motor Free Visual Perception Test (MVPT) and Test of Visual Perceptual Skills (TVPS) found the norms on the SAn population to be higher than the US sample. Higher scores were also apparent in research done by Richter, Griesel and Rose (1992) on the Bayley Scales of Infant Development. As infant development can be influenced by several factors, the need arose to standardise the scale on the SAn population. An extensive difference was found between the SA and US samples, as the SAn babies obtained higher scores on both the mental and motor scales up to the first 12 months.

However, Vorster and Brand (1995) examined the correlation between the Copying Subtest of the Junior South African Individual Scales (JSAIS) and two versions of the VMI, 1982 and 1989, on SAn children to determine whether valid results can be obtained when using the VMI in SA.

Their second aim was to see if a correlation exists between the findings of the tests and the teachers' evaluation of the child's scholastic skills. They found a significant correlation between scores on the VMI (1982 edition) and JSAIS, but an insignificant correlation between the VMI (1989 edition) and teacher evaluation with regard to a child's fine motor skills and concentration.

Differences in the development of children were also found in studies done by Visser et al. (2012) and Smith (2015). The two studies respectively evaluated the performance of SAn children on one and all the subtests of the Developmental Test of Visual Perceptual Skills Second Edition (DTVP-2).

Visser et al. (2012) found that the visual closure subtest is not a valid measuring tool when assessing five-year-old SAn children and they highlighted the importance of a visual perceptual test standardised on SAn children, as discrepancies between the performance of US and SAn children were evident. This correlates with research from Smith (2015), as she found an inconsistency in the performance of five-year-old SAn children compared to US children. The SAn sample obtained average to above-average scores on five of the eight subtests of the DTVP-2. She, therefore, states the DTVP-2 norms "do not translate well to the SA context and the validity of and reliability of the DTVP-2 in SA is questioned" (Smith, 2015, p. 4).

Not only were differences in perceptual development found, but discrepancies were also evident with regard to SI. A study done by Van Jaarsveld et al. (2012) assessed the use of the SIPT on SAn children. The findings indicated that 12 of the 17 tests could be scored using the US normative sample. There were, however, five tests in the older age ranges, where the SAn children performed significantly better than the US sample. They recommended adaptations to be made, half a standard deviation to the negative side, when scoring the relevant five subtests on children older than six years before interpreting the results, ensuring more fair assessment results.

Two undergraduate research studies, with underlying SI roots, also found significant differences in the performance of children residing in SA compared to the US. The two studies involved the same research question, while respectively investigating the performance of three- to five-year-old children from high and low socio-economic (SE) environments on the Test of Ideational Praxis; also a measuring instrument relevant to SI practice (Van Jaarsveld et al., 2013 and Janse van Rensburg et al., 2013). Both studies found children in Mangaung Metro differed significantly from children in the US standardised samples.

From Section A, an understanding was gained that SI difficulties are assessed using various assessment instruments. However, the choice of the assessment measure can depend on the major concerns as highlighted by Stewart (2010, pp. 200-202), but might also be dependent on the feasibility, cost and accessibility of the measurement tools (Stewart, 2010 and Janse van Rensburg et al., 2017). The COs, a cost-effective measuring tool assessing SI functions (Ayres, 1989, p. 1), is used frequently by SAn therapists (Janse van Rensburg et al., 2017). However, the test originated from the US and literature revealed that SAn children do perform differently to US children. This highlights the need for research on assessment measures such as the COs in the SAn context.

As the study is embedded in SI theory (cf. 1.1), it is important to take a closer look at SI frame of reference and sensory processing.

2.3 Section B: Sensory integration

2.3.1 Introduction to sensory integration and sensory processing

Dr A. Jean Ayres, an occupational therapist and psychologist, was the pioneer of the SI theory in the late 1950's. She researched the nervous system and the influence thereof on a child's behavioural responses on the environment (Parham & Mailloux, 2015, p. 259). According to Parham and Mailloux (2015, p. 258) "Ayres ushered a new way of looking at children and understanding many of the developmental, learning, and emotional problems that arise during childhood".

Ayres defined SI as the "organization of sensation for use" (Ayres, 2005, p. 5). In other words, SI is defined as the brain's ability to organise incoming sensory information for functional engagement in daily tasks (Parham & Mailloux, 2010, p. 325), and the word *use* "ties sensory processing to the person's occupation" (Parham & Mailloux, 2015, p. 259).

Ayres originally intended her research to be a theoretical explanation of human behaviour, from where a frame of reference developed, one of two most developed frames of references in OT (Blanche & Kiefer, 2007, p. 12).

In order to understand SI, one must understand how the brain processes information. Sensory processing refers to *registration*, *modulation* and *discrimination* that occur within the different sensory systems.

Registration refers to the brain's ability to register incoming sensory information and can be influenced by a child's neurological threshold which refers "to the amount of stimuli required for a system to respond" (Dunn, 1999, p. 1).

A threshold can be high, which means that more sensory information is necessary for a system to respond, whereas a low threshold means little sensory information is needed for the system to respond. A child will have behavioural responses based on their threshold within each system. *Modulation* refers to the brain's ability to regulate neural messages through facilitating and inhibiting the responses. When the brain is modulated, the central nervous system (CNS) is able to react to important stimuli (facilitate) while ignoring unimportant stimuli (inhibit) to elicit an adaptive response. An adaptive response refers to the child's ability to organise sensory information to perform a "successful, goal-directed action on the environment" (Parham & Mailloux, 2010, p. 327). *Discrimination* refers to the process where the brain can distinguish between sensory information and ascribing characteristics to the sensory information (Parham & Mailloux, 2010, p. 347).

The term sensory processing is "a construct discussed in both the neuroscience and sensory integration literature" (Dunn, 1999, p. 10). From a *neuroscience perspective*, the CNS is viewed as a hierarchical model. The spinal cord is at the bottom, the brainstem in the middle and the cerebral cortex at the top (Parham & Mailloux, 2010, p. 328). Incoming sensory information is perceived through the receptors of the senses. It is transferred via the spinal cord through fibres to the lower levels (Lane, 2002, p. 38). The lower levels (brainstem) are responsible for filtering the sensory information, before sending well-organised information to the cortex, in order for the cortex to analyse the information to plan appropriate action.

The information will then be sent through the spinal cord to the muscles in order to perform an action (Parham & Mailloux, 2010, p. 328). Modulation occurs within the CNS, by regulating the process of habituation, recognising familiar stimuli, and sensitisation, perceiving unfamiliar and harmful stimuli (Dunn, 1999, pp. 8,10).

From a *SI perceptive*, learning takes place by interacting with the environment. By doing this, sensory information is received, processed and used to organise behaviour (Dunn, 1999, p. 11). Ayres (1972) believed the lower levels, particularly the brainstem and thalamus, to be critical in the process of SI (in Parham & Mailloux, 2010, p. 328).

As an understanding has been gained of sensory processing, it is now important to investigate the sensory systems involved, as the child's functional execution of the COs subtests are dependent on effective sensory processing of the relevant sensory systems supporting the demand set within each test item.

Ayres describes sensation as "food" for the nervous system. Every sensation derived from joints, muscles, skin, organs, etc. is perceived by the brain and organised to perform a response within the environment (Ayres, 2005, p. 38). Ayres (2005, p. 57) highlighted three basic sensory systems essential in the foundation of child development, namely the **tactile-**, **proprioceptive-** and **vestibular** systems.

The ten chosen COs subtests for the purpose of this research study respectively rely on these three sensory systems, as they are prominent in supporting a child to perform the ten subtests. Therefore, further investigation into the tactile-, proprioceptive- and vestibular systems was imperative. The three systems will be described in more detail with reference to (1) their functional role in occupation and (2) the subtests used in the COs that allow the therapist to observe the functioning of the respective systems. The subtests themselves will be described in more detail in section 2.4.3. Only a short description of the remaining five systems regarding their functional role in occupation will be provided, as they are not the focus of this study. However, these systems in conjunction with the tactile-, vestibular- and proprioceptive systems are essential in providing a child with adequate sensory processing in effect contributing to optimal functioning.

The **tactile system** interprets information received by the receptors under the skin. The sensation includes temperature, light touch, deep pressure, vibration, and pain. The tactile system is important in emotional and physical behaviour (Ayres, 2005, p. 40). According to Parham and Mailloux (2010, pp. 347-348), the tactile system provides information necessary to engage in everyday tasks. The tactile system is also important in the development of fine motor skills, writing with a pencil, cutting and performing self-care tasks, for example: buttoning shirts, dressing, eating, holding utensils and playing (Parham & Mailloux, 2010, pp. 347-348).

The tactile system has two major sub-systems, contributing to function. This includes the anterolateral system (AL) and dorsal column-medial lemniscal (DCML). The AL serves a protective role and is important in arousal levels as it interprets pain, touch, and temperature. Aversive responses elicited are generated within this sub-system. The DCML carries discriminative sensations; two-point discrimination, vibration, proprioception and deep pressure. The system also plays an integral role in the development of praxis (Kimball, 1993, pp. 94-95).

Functioning of the tactile system can be observed through the following subtests of the COs (SAISI, 2005): Thumb-Finger-touching (TFT) and tactile defensiveness (cf. 2.3.3). Tactile defensiveness can be observed during the testing of the reflexes and Schilders-Arm extension test (SAE).

The **proprioceptive system** is activated during elongation and contraction of joints and muscles. When this occurs, information travels through the spinal cord and brainstem to the cerebral hemispheres. This process occurs unconsciously (Ayres, 2005, p. 41). The system enables us to know where our body is in space and plays an integral role in body movement, motor coordination, arousal level, maintaining an upright posture and judging the amount of force needed to play with toys, for example. Information from the tactile- and proprioceptive systems work closely together as the DCML system transfers both tactile and proprioceptive information. Therefore, Ayres (1989) used the term somatosensory system when referring to the integration of the tactile- and proprioceptive systems (Blanche & Schaaf, 2001, pp. 109-113).

Functioning of the proprioceptive system can be observed through the following subtests of the COs (SAISI, 2005): TFT, Diadokokinesis (DDK), Finger-To-Nose test (FTN) and Standing Balance test (SB). In addition, the Supine Flexion Posture (SFP) gives an indication of somatosensory processing.

The proprioceptive system also works closely together with the **vestibular system** to assist in body movement, coordination, maintaining balance and an upright posture. The system provides information about gravity and head movement.

The receptors, located in the inner ear, are referred to as the utricle and saccule (detect gravity and provide information about linear head movement) and the semi-circular canals (provide information about angular and fast head movement). These structures are filled with fluid and contain hair cells that send signals to the brain, depending on the type of head movement (Kimball, 1993, p. 95).

Functioning of the vestibular system can be observed through the following subtests of the COs (SAISI, 2005): Equilibrium Reactions (ER), SB, Prone Extension Posture (PEP), Gaze Stability (GS) and SAE test.

The **visual system** is important in school engagement, identifying shapes, copying from the board, finding objects in a hidden background and moving through the environment (Schaaf, Schoen, Smith Roley, Shelly, Koomar, & May-Benson, 2010). The **auditory system** transports sound waves from the external ear, into the inner ear and is prominent in hearing and discriminating sounds. The **gustatory system** or taste system detects different tastes. The **olfactory system** or smell system, allows one to identify different smells. The sensation is processed through the limbic system, among others. Therefore, emotional reactions can occur when perceiving and interpreting a specific smell (Ayres, 2005, pp. 39-40). The **visceral system** tells us "about the inside of our body," referring to sensation from the organs and blood flow. The function of the visceral system is to regulate breathing and blood flow, assist with digestion, overall health and survival (Ayres, 2005, p. 42).

2.3.2 Development of the five-year-old child

As the research population was between five and six years of age, literature was consulted as to the development of children in this age group. Table 2.3 provides a summary of the five-to-six-year old's development with regard to play and performance skills.

Table 2.3: Development of five-to-six-year-old children (compiled and adapted from Case-Smith, 2010, pp. 72-77).

	Occupations	**Environment**
PLAY	• Imaginary play • Social and cooperative play • Pretend play • Games with rules • Dramatic play • Building and construction • Ball play • Active play, jumping, skipping, hop-scotch • Rough and tumble play	• Expanding the outdoor environment from home to neighbourhood • Also includes indoor environment for school tasks • Playgrounds in parks, school, and home environment • Preference for quiet space if overstimulated • Will explore new environments
	Sensory-Motor	**Cognitive**
PERFORMANCE SKILLS	• Running pattern matures • Balance on one foot • Skipping pattern • Fine motor skills more developed (in-hand manipulation, dynamic tripod grasp) • Multiple parts on draw-a-man picture • Improvement in bilateral coordination, eye-hand coordination, and praxis • More complex cutting skills • String beads	• Spatial orientation • Construction of 3D designs • Reasoning through simple problems • More abstract thinking during play

The content of Table 2.3 is made possible by accurate sensory processing, as described in section 2.3.1. An understanding of the typical SI functioning, in the developmental stage of the five-year-old child, needs further elaboration, as typically developing five-year-old children, acquiring typical sensory processing to engage in the COs subtests, were included in the study. The elaboration will include the content of Table 2.3 and Ayres's (2005) understanding of the population's SI development.

According to Ayres (2005, p. 24), if a child is between three and seven years, the development of SI is crucial as the brain is most able to receive and organise sensory information. This can be seen in the child's inner drive to explore, not only with his body in the *environment* during *play* but also expanding and seeking new play areas. The child has an inner drive to engage in active play, swimming, wrestling, jumping, running and climbing, as this is fun and meaningful for the child.

The playgrounds also allow for play against gravity which contributes to further developing the nervous system. Dangerous, rough and tumble play is also seen as the child is expanding and exploring his own sensory-motor limits and abilities. At the end of this stage, refinement of motor skills is seen, as the child is able to perform complex motor skills such as hopscotch, jumping rope and skipping.

Cognitive and *sensory-motor* skills are further refined, as the child is almost entering formal schooling. This development allows engagement in school-related tasks such as copying more complex designs, adequate fine motor skills for a typical pencil grasp, cutting and manipulating paper, which is learned and mastered. Tool use for activities of daily living is also developed and includes using utensils during eating, buttoning shirts, manipulating zippers and tying shoelaces (Ayres, 2005, pp. 24-25). As the child grows older, sensory processing still occurs, assisting the child to engage in more complex occupations.

2.3.3 Sensory integration dysfunctions

Difficulty in sensory processing can have an effect on a child's occupational engagement. It is thus of utmost importance to understand the sensory processing problems that might be present in a child, and the COs (SAISI, 2005) can assist the therapist in identifying the sensory processing dysfunction(s), in addition to standardised tests, to ultimately make an SI diagnosis.

Sensory integration dysfunctions occur when a child experiences difficulty interacting effectively with the environment. Ayres (1989, pp. 132-134), in her factor-and-cluster analytic studies, identified four possible patterns of dysfunctions. A study was done by Van Jaarsveld et al. (2014) exploring the patterns of sensory dysfunctions in SAn children, also identified similar patterns of dysfunctions to be present in the SAn population.

The patterns of dysfunction are:

- *Bilateral Integration and Sequencing* deficits: These children have difficulties processing sensory information from the vestibular-and proprioceptive systems (Parham & Mailloux, 2010, p. 349).
- *Visuo- and Somatodyspraxia.* The researcher will describe Visuo- and Somatodyspraxia as separate terms, as they can occur independently from one another.

\- *Somatodyspraxia:* Somatodyspraxia is related to poor discrimination in the tactile and proprioceptive systems in conjunction with praxis difficulties. These children appear clumsy, they experience difficulty in sequencing and timing, novel activities result in frustration and they "have difficulty relating their bodies to physical objects in environmental space" (Parham & Mailloux, 2010, p. 350).

\- *Visuodyspraxia* refers to the "relationship between the visual perception and visually directed praxis" (Parham & Mailloux, 2015, p. 272). Children with visuodyspraxia have trouble using their vision to coordinate body and hand movement, copy drawings and finding objects in a hidden background (Schaaf et al., 2010, pp. 147-148).

- *Generalised SI Dysfunction*: Occurs when a child experiences difficulties in all of the above areas, with all the SIPT scores below average (Ayres, 1989, p. 131).
- *Dyspraxia on Verbal Command*: Although identified by the SIPT, dyspraxia on verbal command is not recognised as a pattern of SI dysfunction, as it is seen as a cortical dysfunction (Ayres & Marr, 1991, p. 227).

Research, accumulated over the years, led to Parham and Mailloux's (2015, pp. 267-273) recent description on SI problems, outlined in "four general categories":

i) *Sensory modulation problems:* When a person is unable to regulate incoming sensory information and respond inappropriately, either under-responding or over-responding to stimuli. Children who over-respond have a tendency to over-react to stimuli in multiple sensory systems and it can also be referred to as sensory defensiveness. It presents in three areas. Firstly, <u>tactile defensiveness</u>: these children tend to avoid touch, textures, etc. <u>Gravitational insecurity:</u> children have a definite fear of movement, they become dizzy and nauseous and dislike having their feet off the ground. Lastly, <u>aversive response to movement,</u> where the automatic nervous system responds to the movement. The child dislikes movement and will easily become nauseous (Lane, 2002, p. 119).

ii) *Sensory discrimination and perception problems:* The child will experience "difficulty distinguishing between different sensory stimuli" (Parham & Mailloux, 2015, p. 270). This can be present in one or multiple sensory systems. The effect of a child's inability to discriminate in a sensory system makes functional engagement, as discussed under each system in section 2.3.1, a challenge and tedious.

iii) *Vestibular-bilateral problems:* Manifest when problems in vestibular and proprioceptive processing occur. These children have difficulty coordinating both sides of their body, appear clumsy, uncoordinated, and have problems engaging in motor activities (Parham & Mailloux, 2015, p. 270).

iv) *Praxis problems:* When a child is unable to conceptualise, plan and execute a new motor patterns it is referred to as dyspraxia. This includes somatodyspraxia, visuodyspraxia, and ideational dyspraxia. When a child experiences problems with ideation, "they have difficulty generating ideas of what to do in a novel situation or conceiving play possibilities when presented with unfamiliar toys or objects … these children may not initiate any activities, or they may initiate activity that is habitual and limited or seems to lack a goal" (Parham & Mailloux, 2015, p. 272).

As we have current knowledge on the different sensory processing dysfunctions, we now need to examine the manner in which to assess them.

2.3.4 Assessment of sensory integration

In assessing SI, a multifaceted approach is used. This includes interviews with relevant stakeholders, standardised testing, informal observations within the child's natural environments and structured COs (Parham & Mailloux, 2010, pp. 351-354).

In order to evaluate a child's sensory processing, Ayres (1989) developed the SIPT, replacing the Southern California Sensory Integration Tests (SCSIT) (Ayres, 1980 in Ayres, 1989, p. 2). The SIPT was standardised on 1997 American children aged four years through to eight years 11 months (inclusive was a sub-sample of 133 children from Canada) (Ayres, 1989, p. 158). The test is suitable for children presenting with irregularities in learning, development and/or behaviour.

The 17 tests assess a child's practic abilities, bilateral integration and sequencing, form and space perception and measure sensory processing form the vestibular, tactile, proprioceptive and visual systems.

This test is considered the "gold standard" for evaluation, and according to Mailloux (1990, p. 589), the SIPT is "…the most sophisticated and psychometrically sound assessment tool to have emerged not only from within the field of occupational therapy but from any field that assesses children's development." Unfortunately, the test is time-consuming and expensive, and therapists also require specialised training in the administration and interpretation of the test (Ayres, 1989, pp. 1-2 and Parham & Mailloux, 2010, p. 353). The current pricing of the SIPT test kit is R15 637.00 and the cost of the four courses required to become ASI certified in South Africa is R32 840 (SAISI, 2018). The three booklets required for the subtests of design copying, kinaesthesia and motor accuracy are R544 for a pack of 25 each, and the SIPT online scoring is R3625.00 (valid for 10 complete SIPT scorings). This amounts to an onset cost of R48 477 to be able to start administering the SIPT, and a recurring cost of R427.78 per SIPT administered. This is excessively expensive, especially in low socio-economic communities.

Ayres (1989) placed emphasis on the multifaceted approach when assessing SI, as she states "The SIPT scores are only one source of data in the evaluative process, and normally should be supplemented by other data and by **Clinical Observations** before any final diagnostic or treatment decisions are made" (Ayres, 1989, pp. 1-2; emphasis added). The term Clinical Observations "typically involve a set of specific procedures that allow the therapist to observe signs of nervous system integrity that are associated with sensory integrative functioning" (Parham & Mailloux, 2010, p. 352). Ayres developed a set of non-standardised structured Clinical Observations (ACOs), intended to supplement the standardised tests she used in clinical practice. This ACOs gave valuable information about the child's quality and coordination of movement, postural stability and primitive reflexes (Ayres 1972a, 1976 in Wilson et al., 1992, pp. 775-776).

However, COs are not only used in the field of SI, but are also utilised within the neurodevelopmental frame of reference. Similar COs to those found in ACOs, are included in the Quick Neurological Screening Test (Mutti, Martin, Sterling, & Spalding, 1998), assessing the presence of soft neurological signs. Thus COs can support the therapist working with a SI or neurodevelopmental frame of reference. With regard to SI specific assessment, the following section will take a closer look at the development of the COs.

2.4 Section C: Clinical Observations

2.4.1 Clinical Observations: A historical perceptive

The original ACOs was a non-rigid protocol with observations and interpretations dependent on the clinician's understanding of SI (Blanche, 2010, p. 7). Over the years, research on the ACOs in America evolved, which was started in 1977 by Ayres's colleague Johnson.

Johnson developed a non-standardised protocol consisting of 19 COs, which were administrated using a three-point scoring scale, subjective to the therapist's interpretation of performance (Wilson et al., 1992, p. 776).

Research from both Ayres (1976) and Johnson (1977) was used by Wilson and her colleagues in 1992 to develop Clinical Observations of Motor and Postural Skills test (COMPS). The COMPS was "not a new test, but rather a revision and elaboration of a commonly used test" (Wilson et al., 1992, p. 776). From the original 19 ACOs subtests, several items were eliminated, one item was added, and the rest stayed unchanged. The COMPS test consisted of seven items, including; Slow motion, Finger-To-Nose (FTN), Diadokokinesis (DDK), Schilder's Arm Extension (SAE), Prone Extension Posture (PEP), Asymmetrical Tonic Neck Reflex (ATNR) and Supine Flexion Posture (SFP) (Wilson et al., 1992, pp. 776-777).

To enhance the objectivity of the ACOs, Dunn (1981) developed A Guide to Testing Clinical Observations in Kindergartners. Dunn (1981, pp. V, 51) agreed with Ayres that COs could serve as supplemental data, and decided to compile a set of procedures that can assist the therapist in the clinical setting. Eighteen items were included and were specifically researched on the five-year-old population. The subtests were: Eye preference and independent eye closure, Eye movements, Muscle tone, Co-contraction, Slow motions, FTN, SAE, SFP, PEP, Symmetrical Tonic Neck Reflex (STNR), ATNR and Reflex Inhibiting Posture (RIP), DDK, Mouth motor planning, Postural security, Rising to stand, Protective Extension (PE), Equilibrium Reactions (ER) and Postrotary Nystagmus (Dunn, 1981, p. III).

Dunn's work was also included in the Observations based on sensory integration theory workbook, compiled by Blanche (2002). The workbook aims to enhance a therapist's assessment skill when using a SI frame of reference (Blanche, 2002, p. 5).

The workbook contains the description of 19 observations including administrative guidelines, normative guidelines for different age groups and the interpretation of the observation within the field of SI (Blanche, 2002, pp. 11-21). The COs included in Blanche's work were similar to those found in Dunn's guide. Tests included were: TFT, FTN, Eye movements, SAE, Antigravity flexion and extension, SFP, PEP, Postural control, Weight-bearing and Proximal joint stability, Gravitational insecurity, Projective action sequences, Bilateral motor coordination, Reactions to sensations, Free play, Play preference and Praxis.

Several authors also investigated individual tests of the ACOs to respectively improve the objectivity, describing developmental trends and age norms, reliability and validity thereof (Harris, 1981, Parmenter, 1983, Gregory-Flock & Yerxa, 1984 and Bowman & Katz, 1984). All of these studies were done on children residing in the US.

Harris (1981) investigated the PEP (cf. 2.4.3 iv) in children aged four, six and eight years, as developmental norms on typical children performing the PEP did not exist at the time. She believed the observations made by the therapists were subjective and depended on the therapist's experience. She, therefore, developed a qualitative scale to enhance more accurate observations to provide more age-specific developmental trends with regard to the duration and quality of the PEP, performed on 84 children from various age groups. The scale contained six observations namely: how does the child assume the posture, position the head, thighs, upper trunk, knees and how does the child maintain the position. Each item was scored a 0, 1 or 2, with a maximum score of 12 to be obtained. She found a significant difference in the duration of the four- and a six-year-old group performing the PEP. The results of the quality of the performance indicated that posture and thigh distance from the mat are important factors in identifying a good PEP from an inadequate PEP.

Gregory-Flock and Yerxa (1984) also researched the PEP on 242 children ranging from four to eight years. The purpose of their study was to standardise the PEP.

The children were assessed using the quality rating scale originally developed by Harris (1981). The results indicated sufficient reliability to continue with the standardisation of the test. The findings of the study were similar to those found in Harris's (1981) study with reference to the four-, six- and eight-year-old children. Unlike the study of Harris (1981), their study found differences in the performance of males and females but attributed it to the difference in sample size. Due to the similar performance of four- and five-year-olds on this test, the study of Gregory-Flock and Yerxa (1984) compiled a table with the expected performance of children aged four and five years, in order to identify vestibular dysfunction more clearly (cf. 2.4.3 iv).

Bowman and Katz (1984) further investigated the PEP on 153 children, adapting Harris' (1981) rating scale, as the scale had several weaknesses. According to the researchers, the language of the scale was confusing, and the scale lent itself to score unobservable behaviours. Their adapted scale also included the same six items as found in studies done by Harris (1981) and Gregory-Flock and Yerxa (1984), but the wording was changed, making the items more exclusive. Their findings on the performance of the PEP was similar to those found by Harris (1981), but their findings indicated a significant difference in item six, maintaining the position, suggesting "…that developmental changes occur in the neuromuscular system between 6 and 8 years of age" (Bowman & Katz, 1984, p. 374).

Parmenter (1983) identified a need to develop a quantitative rating scale when assessing the ATNR (cf. 2.4.3 v), to identify parameters more clearly, in order to determine the reasonable expectations of children across different age groups. The rating scale included four items, namely (1) loss of balance, (2) elbow flexion 60° and more, (3) elbow flexion between 31°-60° and (4) 0°-30° elbow flexion. The child's head was moved to the side, with four recordings made on each side. A maximum score of 32 could be obtained. A score below 28 for the first graders and a score below 31 for third graders were considered a decreased inhibited ATNR.

The above-mentioned studies strived to improve the objectivity, reliability and age norms of the respective COs items. It was, however, done on only two items (PEP and ATNR) and the study of Gregory-Flock and Yerxa (1984) was the only study that included five-year-old children.

As an understanding was gained on the historical perceptive and research done on the COs in the US, the researcher also investigated the research process done on the COs in SA.

2.4.2 Development and research in South Africa

In SA, the South African Institute for Sensory Integration (SAISI) adapted the ACOs in 1986 (SAISI, 1986) into a more comprehensive booklet that included detailed information on administration and interpretation of the COs. The SAISI 1986 COs were revised by the SAISI education committee in 2005, mainly in terms of clarity and editing (SAISI, 2005).

The COs (SAISI, 2005), contains 24 observations, similar to those included in the work of Dunn (1981) and Blanche (2002). The following items are included in the COs (SAISI, 2005): Muscle tone, Eye preference, Independent eye closure, Eye movements, Slow movements, DDK, TFT, Tongue-lip movement, Co-contraction, Postural/Gravitational security, ER, Protective Extension (PE), PEP, ATNR, STNR, SFP, SAE, Hyperactivity, Tactile defensiveness, Postural background movements, Jumping, Hopping, Skipping, Throwing and Catching.

The procedures for administration and scoring, normative guidelines and general observations along with interpretations of these observations are included in the booklet (SAISI, 2005). The normative guidelines used in the COs (SAISI, 2005) were based on literature gathered from previous research done by researchers such as Ayres (1972a), Dunn (1981), Harris (1981) and Parmenter (1983). The normative guidelines included in the booklet were not investigated specifically on the SAn population. Therefore, the norms currently used are based on research older than 20 years, researched on a non-SAn population.

SAISI is again in the process of revising the COs (SAISI, 2005), but the revised COs working document (Cook, Olivier, & Van Jaarsveld, 2016) is still in an early phase, and the working document was made available for this research study.

Table 2.4 illustrates the composition of the revised COs working document, further referred to as revised COs (Cook et al., 2016).

Table 2.4: Composition of the revised COs working document (compiled by the researcher from Cook et al., 2016).

		Child's response:		***Sensory Systems:***
Sensory Processing	**Registration**	Delayed Yes/No	Within each system	Visual Vestibular Proprioceptive Tactile Auditory Olfactory
	Modulation	Under/Typical/Over responsive		
		Components included:	***COs subtests assessing components:***	
	Discrimination	Primitive Postural Reflexes	ATNR, STNR, PEP, SFP, ER, PE	
		Vestibular components	Standing balance	
		Proprioceptive components	Proximal joint stablity	
		Vestibular-ocular components	Eye movements, Gaze stability, Eye tracking	
		Postural Occular components	Postural ocular reactions, SAE	
		Bilateral Integration and Sequencing	Slow movements, DDK, TFT, Bilateral ball hitting, Jumping two feet, Midline crossing, Laterality	
		Tactile-Proprioceptive processing	Touch-accuracy	
		Somatosensory processing	Haptic Manipulation, FTN	
		Praxis	Ideation, Tongue movements, Projective action sequences, Other observations	

As seen from Table 2.4, the document is more comprehensive than the currently used COs (SAISI, 2005), and can provide therapists with more detailed observations over all three areas of SI as discussed in section 2.3.1. This will provide SAn therapists with more in-depth observations, as they cannot always afford to perform standardised tests, with the implication that they can only rely on clinical observations made (Van Jaarsveld, 2016). It is thus of importance for these observations to be as complete and comprehensive as possible. This was especially an important factor in SAISI's consideration to revise the COs (SAISI, 2005) (Van Jaarsveld, 2016).

SAISI has published an observational instrument on gross motor items (Cook, Agenbag, Malengre, McDougall, Visser, & Ziervogel, 2004). During the compilation of the gross motor items, videos were used to establish age-related norms, and it was clear that more detailed performance indicators can be provided when videoing children during execution of items.

To enhance the reliability, age norms and performance indicators or general observations as to how the child executes the actions, were thus included in the working document (Cook et al., 2016). The committee found through years of practical experience and the development of the gross motor items, that discrepancies occur between the performance of children from different age groups. Having age norms for the COs, will thus enhance more accurate age-specific assessment.

The addition of the performance indicators can provide valuable information about the child's body position, quality of response, speed and smoothness of movement, etc., each observation made specifically for the individual subtest. These performance indicators will not only assist the therapist in the scoring process, but enhance the SI trained OT's reasoning on patterns of dysfunctions, as it is important in the clinical reasoning process to observe the manner in which the child executes the COs to make a SI diagnosis (Van Jaarsveld, 2016). There is thus a need for research on the performance of SAn children on different items within the revised COs working document, in order to complete and use it in SA (Van Jaarsveld, 2016).

The ten subtests included in the study were selected from the COs (SAISI, 2005), and the current revised COs working document (Cook et al., 2016). The reason for the selection of the ten items will be discussed in 2.4.3. The findings of this study relating to the observable and measurable characteristics of the performance of five-year-old children can potentially be included in the current working document (Cook et al., 2016), contributing to the value and effectiveness of the use of the COs on the SAn population.

2.4.3 Ten chosen subtests

Ten subtests were chosen for this study mainly in order to enhance the feasibility of the research execution. Although funding was made available for the research, it was still necessary to limit the items. Additional contributing factors for confining the study to ten COs items were:

- Time constraints, as the researcher was responsible for testing the research sample. The study, therefore, had to be limited to ten subtests, manageable and fundable by the resources available.
- Ayres (2005) highlighted three prominent sensory systems in supporting a child, namely: tactile-, proprioceptive- and vestibular systems. The ten chosen subtests represent all three sensory systems and will provide the therapist with information to assist in the reasoning process of these systems.
- These subtests were also chosen as they are included in the revised COs (Cook et al., 2016), and as previously stated, there is a definite need for research in SA, in order to complete the currently revised COs.

The ten subtests chosen for the research were: DDK, TFT, ER, PEP, Tonic Neck Reflexes (ATNR, RIP, STNR), SFP, SAE, FTN, GS and Standing Balance.

For the purpose of this study the literature related to the relevant ten subtests will be perused with a focus on the nervous system and anatomical structures involved, performance and norms of five-year-old children growing up in SA, the scoring procedure, relevancy to OT assessment and SI, and limitations in literature w.r.t. each of the ten subtests.

i) Diadokokinesis (DDK)

DDK is the ability to perform rapidly alternating sequential supination and pronation movements of the forearm (Levine, Brooks, & Shonkoff, 1980, p. 137 and SAISI, 2005, p. 16). According to Levine et al. (1980, pp. 132-134), the test can be of value in assessment of soft neurological signs to serve as an indicator of central nervous system (CNS) maturity and efficiency and is included in neurological assessment measures such as the QNST (Mutti et al., 1998).

The test is used to specifically assess cerebellar function (Touwen, 1979, p. 59). One of the functions of the cerebellum is to assist the CNS to predict future body movements, especially during rapid movement. The limb's rapid movement is detected by the cerebellum through proprioceptive signals and predicts "the projected time course of movement" (Guyton, 1976, p. 169). "This allows the cerebellum, operating through the cerebellar output circuits to inhibit the agonist's muscles and to excite the antagonist muscles when the movement approaches the point of intention"

(Guyton, 1976, p. 169). According to Bickerstaff (1976, p. 208), patients with cerebellar dysfunction can be expected to perform the DDK irregularly, with slow and jerky movements.

The test is also used to assess SI dysfunctions (Bundy, 2002, p. 181). DDK is of importance in SI, as it gives information about a child's somatosensory processing, praxis, and bilateral integration and sequencing abilities (SAISI, 2005).

Dunn (1981, p. 32) established that a five-year-old child is able to perform, within ten seconds, four complete forearm repetitions on the thighs. Wilson et al. (2000 in Bundy, 2002, p. 181), however, found that five-year-old children are able to perform nine and more repetitions in ten seconds. A study was done by Denhoff, Siqueland, Komich and Hainsworth (1968, p. 234), which found that 95% of children aged six years to seven and a half years, were able to perform this action on the Meeting Street School Screening Test. However, the researchers did not elaborate on the normative or qualitative performance of this test.

The quantitative data, as well as the quality of the child's performance, needs to be considered when scoring the DDK test (SAISI, 2005). Limited research is available describing age-related performance on the DDK test "as most authors do not go into detail about specific-age-related observations but stress symmetry of execution, rhythmicity, and smoothness of movement" (Mutti et al., 1998, p. 61). Dunn (1981, p. 32) mentioned that the presence of only one observation should be expected to be present in the five-year-old's performance of the DDK test, namely: no left and right differences should be evident. The researcher was unable to find additional expected observations that should be present in a five-year-old child during the DDK test assessment.

Touwen and Prechtl (1970, p. 43), however, provides observations that can be used when scoring the child's performance. Asymmetry between the two sides of the body and the presence of associated arm movements, influenced by the child's dominance, can be expected (Touwen & Prechtl, 1970, pp. 43,44). The challenge, however, is that these observations are not clearly related to a specific age group, making it difficult to interpret when it is present during testing. In addition, Mutti et al. (1998, p. 43) states, floppy movement, and poor muscle tone can be expected from younger children, but did not clarify the age group.

Dunn's (1981) expectations for the five-year-old child on the DDK test is incorporated into a three-point scoring scale of "normal," "slightly deficient" and "definitely deficient," which is currently used in the COs in SA (SAISI, 2005). When the child is unable to perform the expected movement patterns, the scoring of slightly and definitely deficient is subjective to the therapist. The subtest does not include additional descriptions on the quality of the exhibited performance which might increase the scoring scale's objectivity.

ii) Thumb-Finger Touching (TFT)

TFT allows the therapist to observe the child's ability to touch each finger in a sequential manner with the thumb of the same hand (SAISI, 2005, p. 18). A similar test, "thumb and finger circle," is included in the QNST (Mutti et al., 1998), where the child is asked to make circles with his thumb by touching each finger, starting with the index finger and continuing with the sequence up to the little finger. A score of either 1 or 3 is allocated to the child, depending on the sequence, forming of the circle, movement of opposite side and if the position held, is tense (Mutti et al., 1998, pp. 24-25). The observations gained from this test are of value to the therapist, as the test can observe cerebellar functioning (Blanche, 2002, p. 12). Associated reactions with the opposite hand and/or leg, tongue movements and inability to make adequate circles with the fingers can be indicators of "non-independent muscular activity" as well as "poor muscle-directing capacity" (Mutti et al., 1998, pp. 41-42).

TFT is also useful in the assessment of SI functions (Blanche, 2002). Within SI assessment, the child is asked to touch each finger with the thumb, moving from the index to little finger and back again to the index finger, with eyes open and closed. The child is asked to perform the action with the right, left and both hands. To be able to perform the test, the child needs adequate tactile and proprioceptive feedback, bilateral hand movements (when performing with both hands), praxis and adequate sequencing abilities. These named areas of performance are observed by the therapist while the child executes the actions (Blanche, 2002, p. 12; Bundy, 2002, p. 180 and SAISI, 2005, p. 63).

The development of this skill is not expected of the five-year-old child (SAISI, 2005) and was not included in Dunn's (1981) work. In contrast, Page-El and Grossman (1973 in Mutti et al., 1998, p. 60) state five-year-old children can perform the test and according to Denckla (1973), the skill increases between the ages of five and seven years. The results from the "thumb and finger circle" test of the QNST, on an undifferentiated group of children, indicated 50% of children aged five years will be able to perform this test successfully (Mutti et al., 1998, p. 68). Research found the skill tends to be more integrated in females as a significant difference was found between genders (Mutti et al., 1998, p. 60) and improved performance of the dominant hand can be expected (Mutti et al., 1998, p. 60 and SAISI, 2005, p. 63).

Denckla (1973) investigated the performance of 237 normal children aged five- to seven-years with right-hand dominance, on repetitive and successive finger-movement. The "repetitive finger-movement" entailed that the child should repeatedly touch the index finger with the thumb and the "successive finger-movement" entailed that the child should perform a sequence with the thumb, starting from the index finger, moving to the little finger without going backward. Each participant had to perform both patterns 20 times, and the researcher recorded the time of each performance. The study found that the children performed better in speed during the "repetitive finger-movement" with the right hand, but both hands were equally proficient during the "successive finger-movement." They also found, over all ages, that the boys performed the "successive finger-movement" slower than the girls (Denckla, 1973, p. 640). Similar results were also found in a follow-up study done by Denckla (1974).

During a child's execution of the TFT, various researchers described additional observations that can assist the therapist in the interpretation process. Associated reactions of the mouth and opposite hand (when executed unilaterally), ability to move fingers individually, use of vision, sliding and/or pressing hard on the tips of the fingers serve as useful indicators in identifying SI dysfunctions (Blanche, 2002, p. 12 and SAISI, 2005, p. 63). The indicators assist the therapist in allocating a score using the current three-point scoring scale of "normal', "slightly irregular" and "definitely poor" (SAISI, 2005). Even though these indicators are used when assessing a five-year-old child, no research could be found describing the age at which the presence of these indicators is typical to expect in a child performing the TFT. General observations are thus made, non-age-related, and interpreted accordingly. As a result, potentially compromising the accuracy of the evaluation.

iii) Equilibrium Reactions (ER)

ER enables a child to control the body's centre of mass in relation to the supporting base (Fisher, 1989, p. 58). "These reactions are mediated by the efficient interaction of cortex, basal ganglia and cerebellum" (Fiorentino, 1973, p. 38). As ER matures, it assists the child in the motor developmental stage of walking. The skill develops from six months and matures as the child grows older (Fiorentino, 1973, p. 38). When ER are present, it indicates "…the next higher level of motor activity is possible" (Fiorentino, 1973, p. 38).

ER are detected by the vestibular apparatus (Guyton, 1976, p. 142). The bony labyrinth consists of a membranous labyrinth that contains three semi-circular canals and two chambers, the utricle, and saccule. All three structures play an important role in maintaining equilibrium (Guyton, 1976, pp. 142-143). Within the wall of the chambers, a sensory area, known as the macula, detects head orientation. The macula contains hair cells, embedded with the vestibular nerve. Any movement of the head activates the hair cells and transmits signals from the vestibular nerve to the vestibular nuclei and sends the remaining fibres to specific parts of the cerebellum controlling equilibrium (Guyton, 1976, pp. 142-143). ER also relies on proprioceptive information from the neck as well as other body parts, as body adjustments need to be made in order to maintain equilibrium. Sensory impulses from the cerebellum and reticular area of the brain stem cause adjustments to be made within the postural muscles, making necessary body adaptations possible (Guyton, 1976, p. 148).

ER are, therefore, used in SI assessment to assess the processing of the vestibular and proprioceptive systems (Bundy, 2002, p. 177). In the assessment of ER, the therapist must observe both the quantitative and qualitative response of the child (Fisher, 1989, p. 58) as these observations can provide additional insight into the child's SI processing (Bundy, 2002, p. 177).

Fisher (1989, p. 58) states that the evaluation of ER is subjective with common assessment measures including placing the child on an unstable surface, displacing a child on a stable surface or asking the child to move out of his centre of gravity by reaching towards a target. Grading takes place according to the child's response, with the ER either being present or absent.

However, according to Fisher (1989, p. 58), there is inconsistency in the literature regarding which body movements can be expected. Bundy (2002, p. 177) also states that a variety of standardised tools are used in the assessment of equilibrium, but none provides qualitative information.

Fiorentino (1973, pp. 39-49) reported normal ER for several positions including supine, prone, four-point kneeling, sitting, kneel-stand and hopping. The common typical response in almost all of these positions was extension and abduction of both upper and lower limbs to the raised side, protective extension to the lowered side with the head and trunk being upright. According to Fiorentino (1973, p. 39), if these positive reactions are not present after 12 months, it can be an indicator of “delayed reflex maturation.”

Dunn (1981, p. 42) also provided qualitative information of the five-year-old child performing the ER test. Her observations included that they maintain more tilt in a seated and prone position. Further, a protective extension is elicited after 15° tilt when upright.

Fisher (1989) also opted to describe the quality of ER in more detail, by designing a qualitative rating scale when scoring balance with two tests, namely: “Tilt Board Reach” (TBR) and “Flat Board Reach” (FBR). A number of 147 typical boys and 156 typical girls between four and eight years were included in the study. The TBR entailed that the child should stand on a tilt board and reach with the ipsilateral hand to an object placed at shoulder height. The FBR used the same method, but the participants were asked to stand on a flat surface. The children’s responses were recorded in both positions while instructed to reach towards a target (Fisher, 1989, pp. 63, 64). Six possible patterns of responses were identified (Fisher, 1989, pp. 65-66). The results indicated no gender difference and the results of the four- to the six-year-old group indicated they used patterns I and III the most. Pattern I is described as feet remain on the supporting surface and arm flexion at the elbow. Pattern III is described as arm abduction/extension and abduction of leg >30° (Fisher, 1989, p. 71). Even though the descriptive data is valuable, the procedure and administration used by Fisher (1989) differ from the assessment method currently used in SA.

In the COs (SAISI, 2005), the child is asked to assume several positions on a tilt board. During this time, the therapist can evaluate the absence or presence of the ER while slowly moving the board to the sides. A list of observations is available, yet again, not age specific. As a result of limited available research investigating the qualitative response of the child when assessing equilibrium, the therapist is forced to make use of her own clinical knowledge, leading to subjective assessment (Bundy, Fisher, Freeman, Lieberg, & Israelevitz, 1987, p. 29).

iv) Prone Extension Posture (PEP)

PEP involves the extension of upper and lower limbs while lying prone on the floor (SAISI, 2005). The observation of the PEP is essential in SI assessment as it measures vestibular-proprioceptive processing (Blanche, 2002, p. 16).

Several studies have been conducted on the PEP. Dunn (1981, p. 25) investigated the duration of PEP in five-year-old children and found they are able to only maintain extension of the head and upper body for 15-20 seconds, but not with legs extended and lifted off the floor. The quality of performance and/or additional observations while executing the PEP were not included in Dunn's study.

A study conducted by Harris (1981, p. 27), however, included both duration and quality of PEP performance. She used a qualitative rating scale (cf. 2.4.1) which entails observations of the neck, head, thighs, and knees while assuming and maintaining the posture (Harris, 1981, p. 28). Although her study was more descriptive, her population did not include five-year-old children, it did not consist of a diverse socio-economic class (Harris, 1981, p. 30) and her scale had limitations (Bowman & Katz, 1984, p. 368) (cf. 2.4.1).

Harris's (1981) qualitative rating scale was included in the studies of Gregory-Flock and Yerxa (1984) and Bowman and Katz (1984). They respectively converted data from the rating scale into two tables to assist therapists in identifying vestibular dysfunction more clearly (Gregory-Flock & Yerxa, 1984, p. 193).

In addition, they also adapted the rating scale (Bowman & Katz, 1984, p. 370). The results of Gregory-Flock and Yerxa (1984, p. 193), included descriptive observations of the five-year-old child when performing the PEP. Sixty percent of the participants were able to assume the posture smoothly, raising body parts simultaneously, 40% with knees off the mat, 35% with thighs clearly off the mat and 50% were able to maintain the position with moderate exertion.

Bowman and Katz (1984, p. 374) found "…that as age increases; the child is less likely to exhibit swaying of the body, movement of the extremities, facial grimaces, choreoathetoid movements, or difficulty counting aloud while maintaining the prone extension position."

Harris (1981, p. 29) emphasises the importance of knowing the exact developmental expectations, in different age levels, when distinguishing typical from atypical children. Nonetheless, the current administration is done on a three-point rating scale using Dunn's (1981) findings when scoring a five-year-old child with additional observations available, but none are age-related and serve only as a general guideline (SAISI, 2005, pp. 29-30).

v) Tonic Neck Reflexes: ATNR, RIP & STNR

Reflexes, or motor patterns in infancy, are stereotypical and manifest when tactile, vestibular and proprioceptive stimuli are applied (Colangelo, 1993, p. 235). Reflexes firstly enables the initial interaction between the infant and environment (Case-Smith, 2010, p. 56), secondly it provides the child with additional sensory information to assist in motor control (Colangelo, 1993, p. 235), a prerequisite for the development of higher-order skills (Case-Smith, 2010, p. 57) and it is critical in the development of motor milestones, enabling the child to progress from rolling to walking (Fiorentino, 1973, p. 5).

Primitive reflexes such as the ATNR and STNR are brain stem reflexes, facilitated by the Deiters' nucleus located in the basal ganglia (Fiorentino, 1973, p. 13 and Capute, Wachtel, Palmer, Shapiro, & Accardo, 1982, p. 314).

These static postural reflexes bring forth changes in muscle tone in the body, in response to changes in the position of the head. It is expected that both positive and negative reactions can be present when testing the reflexes in children aged four to six months (Fiorentino, 1973, p. 13). If these reflexes persist after six months, it is an indication of "delayed maturation of the central nervous system" (Fiorentino, 1973, p. 13), or as described by Zafeiriou (2004, p. 6), an indication of cortical disinhibition.

Testing of the reflexes is important when using a neurodevelopmental frame of reference. The testing of reflexes is often done by neurologists to assess the CNS (Fiorentino, 1973; Levine et al., 1980 and Zafeiriou, 2004, p. 1), but testing of the reflexes is also valuable when using the SI frame of reference (Parmenter, 1983, p. 1 and Kimball, 1993, p. 125-126). Research found a relationship between reflexes and sensory processing, as the presence of reflexes past three years of age, could be a result of poor sensory processing (Goddard 1996 in Taylor, Houghton, & Chapman, 2004, p. 24).

Children with SI disorders tend to have overactive reflexes, specifically referring to the ATNR and STNR (SAISI, 2005, pp. 72, 74). The presence of the ATNR and STNR beyond the typical developmental stage, where they fulfill a functional and supportive role, can possibly indicate amongst others postural control difficulties (SAISI, 2005, pp. 73, 74). These reflexes need to integrate in order to enable higher order skills such as adequate righting reactions and equilibrium (Fiorentino, 1973), components important for the development of postural control. Righting reactions enable alignment of the head with the body against gravity and equilibrium reactions provide the body with stability and assist the child in maintaining balance (O'Brien & Williams, 2010, p. 255).

Studies done by Capute et al. (1982) and Capute, Palmer, Shapiro, Wachtel, Ross and Accardo (1984) assessed the primitive reflexes in infants from 0-24 months. The children's reflexes were assessed with each clinic visit using the "primitive reflex profile." The results respectively found less than 30% of the 149 normal participants elicited the STNR at age two (Capute et al., 1982). The presence of the ATNR in the 381 participants declined through the first 12 months, and an absence in the reflexes was seen in 90% of children aged 24 months (Capute et al., 1984). The rest of the population presented with no change in body position, but changes in tone (Capute et al., 1984). Several studies also assessed the reflexes in older children (Dunn 1981; Parmenter, 1983 and Zemke, 1985).

Dunn (1981, p. 29) assessed the ATNR and STNR of five-year-old children, by measuring the degree of contralateral elbow flexion in a four-point kneeling position, while turning the child's head to the side. She found five-year-old children to have a mean of 55° elbow flexion, but concluded that her findings are not reliable to use when assessing a child. She suggested to rather observe if the child is able to assume and maintain the reflex inhibiting posture, before making a conclusion (Dunn, 1981, p. 29). Dunn, however, did not elaborate on the reflex inhibiting position.

Further studies aimed at providing more normative data on the ATNR reflex in children, using the ATNR rating scale (cf. 2.4.1). Parmenter (1983) assessed 44 children attending grade one and 36 third graders. Her results indicated a score of 28-32 when using the ATNR rating scale, as reasonable to make the conclusion of an inhibited ATNR. She also found the reflex is more significant in first graders as they presented with elbow flexion of 31°- 60° (Parmenter, 1983, p. 463). Zemke (1985) assessed 20 children aged three and five years and the results were similar to those of Parmenter (1983). For the ATNR to be seen as inhibited in the five-year-old child, a score of 26-31 must be obtained. Zemke (1984 in Zemke, 1985, p. 178) also reported, from a previous study, that an elbow flexion of 32° can be expected of the five-year-old child. Even though the results are of value, it does not provide the therapist with the precise performance expectation of the five-year-old child.

Assessment of the STNR is similar to the positioning of the ATNR, with the neck being moved into flexion and extension. For the STNR to be present, 25° elbow flexion is seen as significant (Dunn, 1981, p. 27).

Currently, reflexes are assessed in the same method as described by Dunn (1981) in the COs (SAISI, 2005). A three-point scoring scale is used, with the normative data of elbow flexion more than 25° as an indicator of the presence of the reflexes (SAISI, 2005, pp. 31-35, 72-74). With the assuming of the reflex inhibiting posture, no definite norms are present as to how long a five-year-old child should be able to assume the posture for the reflex to be seen as integrated (SAISI, 2005, p. 33). In addition, there is also no descriptive information available on the typical performance of the child on the reflex inhibiting position. No further research could be found which re-evaluated the ATNR and STNR COs (SAISI, 2005) items.

vi) Supine Flexion Posture (SFP)

SFP entails that a child should maintain a flexed posture against gravity while lying on his back (SAISI, 2005, p. 36).

Stockmeyer (1967, pp. 906-909) interpreted the work of Rood on the treatment of neuromuscular dysfunction and described the SFP as a significant step in motor development in infants. Within motor development, one of the important sequences is voluntary or skeletal functions from which mobility and stability are developed. It develops as a sequence, with withdrawal supine being the first pattern, serving a protective role (Kiernan, 1998, p. 101). As the flexor position is held, the tonic labyrinthine reflex (TLR) integrates. The voluntary flexion takes place, even though the TLR facilitates extension. Daub (1978 in Fraser, 1986, pp. 31-35) believed the SFP emerges at age five months, as the corticospinal tracts in the cortex allow more skilled movements, facilitating flexion of the limbs (Noback & Demarest, 1975, pp. 170-171). From there on rolling, extension, co-contraction, prone on elbows, prone in all fours, standing and lastly walking takes place (Stockmeyer, 1967, pp. 906, 907 and Fraser, 1986, pp. 31-32).

"It is postulated that the cortical mechanisms involved with motor planning are also involved with the facilitation of muscular flexion. Therefore, an impairment in the ability to attain the supine flexion posture could suggest an impairment in the ability to motor plan, evolving from the cortex" (Fraser, 1986, pp. 35-36). Blanche (2002, p. 15) outlines the importance of SFP in assessing SI, as the flexor pattern is associated with somatosensory processing and a child's motor planning abilities can also be derived from the test (SAISI, 2005, p. 75). "The ability of a child to assume and hold the supine flexion posture is a good indicator of the degree of integration of the TLR, which may, in turn, indicate the child's degree of praxis" (Fraser, 1986, p. 34).

The TLR can interfere when a child assumes the SFP, as the reflex is aroused by gravitational force increasing the extensor tone when in a flexed position (Fraser, 1986, p. 33). The degree to which the TLR is integrated can be seen through the child's ability to resist the pull of gravity, increasing the exerted force of the flexor muscle to maintain the flexed posture (Fraser, 1986, p. 33).

Ayres (1972 in Fraser, 1986, pp. 31-32) states a child's muscle tone must be considered during the SFP. Hypotonic children will usually be able to take in the SFP, but will be unable to hold the position.

This test is included in the work of Dunn (1981), Blanche (2002), SAISI (2005) and the revised working document (Cook et al., 2016).

Short, Watson, Ottenbacher and Rogers (1983) attempted to clinically investigate the performance of 156 four-year-old children's vestibular-proprioceptive functioning, with the use of several clinical observations, including the SFP. Their second objective was to obtain normative data for these measuring instruments. They found four-year-olds could maintain the SFP for 14.30 seconds. Similar findings were found by Dunn (1981), assessing the SFP on five-year-old children. She reported, "it seems reasonable to expect five-year-olds to execute the supine flexion position and hold it without resistance for a period of time" (Dunn, 1981, p. 21). The majority of children were able to assume the position for 11-20 seconds (Dunn, 1981, p. 21).

A study done by Fraser (1986), attempted to standardise the SFP on 242 typically developing children aged four to eight years using a convenience sample. She found 30 children aged five years naught months to five years four months were able to keep the posture for 20.93 seconds. The older range included 21 children aged five years five months to five years nine months. They were able to keep this position for 38.86 seconds with a mean of 34 seconds (Fraser, 1986, p. 57). Her results indicated many children under age six, were unable to maintain this posture. Her study did not include dyspraxia children for purposes of comparison, and this led her to the conclusion that "this measure may be inappropriate for discriminating children with possible dyspraxia below age 6" (Fraser, 1986, p. 71).

However, a study done by Wilson et al. (1992) investigated the reliability and validity of the COMPS (cf. 2.4.1). One of the subtests were SFP, and they revealed that the SFP, together with PEP, is "the best discriminators for 5-year-olds" (Wilson et al., 1992, p. 781).

Dunn's finding of 1981 is used in a three-point scoring scale in the COs (SAISI, 2005) with no description available on the quality of typical performance, specifically related to the five-year-old child (SAISI, 2005, p. 37).

vii) Schilder's Arm Extension (SAE)

The test requires a child to stand feet together, head in mid-position, arms stretched out in front, palms facing downwards and eyes closed for several seconds. Thereafter the same position is assumed in, and the child's head is slowly turned to the sides (SAISI, 2005, p. 38).

Traditionally the SAE test is seen as a neurological test to assess cerebellar integrity (Blanche, 2002, p. 14). During the test, the therapist observes the motor response present while the child performs the action. The proprioceptive system is responsible for a motor response, positioning of body parts, direction and range of movement as well as involuntary movements (Guyton, 1976, pp. 169-170 and Kiernan, 1998, p. 351). Proprioceptive sensation derived from the joints, tendons and muscles travels through the dorsal sensory pathway, known as the medial lemniscus system to the cerebellum where signals are then sent back to the motor cortex to provide a motor response (Guyton, 1976, pp. 95-99 and Kiernan, 1998, p. 351). Research in SI, related the test to the assessment of vestibular proprioceptive processing (Blanche, 2002, p. 14).

The test procedure, described by Touwen (1979), is similar to the procedure in SI, but the child is also asked to supinate the arms while performing the action with eyes open and closed without turning the head to the sides. The child is scored on four criteria: arm deviation in both horizontal and median line (sidewards), spooning of the hands and the degree of pronation (Touwen, 1979, p. 49). The child can obtain a score of 0, 1 or 2 on each criteria. It is typical to expect a child under six years, to have upward deviation when the arms are pronated and a downward deviation during supination. A slight deviation to the sides can be present in this age group, but is not common in children older than six years and can possibly be an indicator of hypotonia. In this age group, spooning that is accompanied by flexion of the wrist joint and hyperextension in the metacarpophalangeal joints is also common. It is common for children under the age of five years to obtain a score of one on the pronation criteria, as pronation of 30°- 60° can be expected (Touwen, 1979, pp. 49-51).

Dunn (1981) also provides additional information on the expected motor response of typical five-year-old children while performing the SAE test. Trunk rotation of 45° can be expected when the head is turned 90°, with slight involuntary finger movements while experiencing no discomfort or resistance when turning the head (Dunn, 1981, pp. 18-19 and SAISI, 2005, p. 76).

To the researcher's knowledge, this is the only literature available from which qualitative descriptions on the performance of five-year-old children on the SAE test were found. Both observations found by Dunn (1981) and Touwen (1979) respectively done on American and European populations are used in the COs (SAISI, 2005, pp. 38-39) to serve as a guideline when scoring SAn children on this test.

viii) Finger-To-Nose (FTN)

The test examines the child's ability to bring forth the index finger from a 90° extended lateral arm position and touch the nose while in a seated position (Dunn, 1981, p. 15 and Blanche, 2002, p. 12).

The test is used in neurological assessment (Touwen, 1979) to assess cerebellar function (Blanche, 2002, p. 12) and is included in the QNST (Mutti et al., 1998), as the test is valuable when assessing for soft neurological signs in children older than five years (Mutti et al., 1998, p. 60).

The test, however, also relies on sensory processing from different systems (Touwen, 1979, p. 61) and is included in the work of Dunn (1981), Blanche (2002) and the revised COs (Cook et al., 2016) to specifically assess somatosensory processing (Blanche, 2002, p. 12). Touwen (1979, p. 61) and Mutti et al. (1998, p. 41) highlights the importance of the proprioceptive system during this assessment, especially when the child is asked to perform the action with vision occluded.

In the assessment of FTN, as described by Touwen (1979, p. 60), the child is upright, hands at the sides of his body, and asked to touch his nose, first with eyes open and then closed. The child is scored and can receive a score of 0, 1 or 2 according to two categories: smoothness and adequacy. According to Touwen (1979, p. 61), a score of 0 is optimal for the five-year-old child. A score of 0 on smoothness entails no tremor, and a score of 0 on the adequacy category entails the child to correctly place his fingertip on the tip of the nose, each time he performs the action.

Five-year-old children should also not rely on visual cues, as this is expected of children younger than five years, nor should they support the elbow against the body, as it can be an indicator of a delay in maturation, "differentiated arm motility" or hypotonia (Touwen, 1979, p. 61).

Dunn (1981, p. 16) supports the findings of Touwen (1979) as she also found five-year-old children are able to correctly touch the tip of their nose, within 1.5 centimetres, vision occluded, and will have the ability to rectify themselves if they are not on target. Mutti et al. (1998, p. 68) found 50% of children aged five years three months, were able to perform the action with success and children aged six years should be able to perform the task smoothly (Mutti et al., 1998, p. 59).

Mutti et al. (1998, pp. 40-41) highlighted the following observations that can be made by the therapist to serve as indicators for underlying problem areas: (1) if the child performs the action slowly, it can be an indication of either difficulty in motor planning or motor control; (2) if the child misses the tip of the nose or the hand wanders in different directions, the child may have difficulty with body in space perception. Additional observations of symmetry, tremor, rhythm, rate, smoothness, right/left differences and associated movements can also be observed during the test (Mutti et al., 1998, p. 59 and Blanche, 2002, p. 12). However, none of these have been described in terms of typical performance of five-year-old children in order to interpret whether these observations should or should not be expected to be present in the five-year-old child.

The test was not part of the COs (SAISI, 2005), but is included in the revised COs (Cook et al., 2016) and scored using a five-point scoring scale.

ix) Gaze Stability (GS)

GS is the ability of the eyes to stabilise the visual field when the head moves (Sağlam & Lehnen, 2014, p. 425). Eye movement can be provoked by activating the vestibular apparatus (Guyton, 1976, p. 267). The vestibular nuclei include the superior, medial and inferior nuclei, and is located in the medulla and caudal pons (Kiernan, 1998, p. 402). The pons in turn is directly connected to the nuclei in the brain stem which controls ocular movement (Guyton, 1976, p. 267).

The fibres of the medial vestibular nucleus cross with the oculomotor nucleus of the midbrain to provide “conjugate movement of the eyes, coordinated with movement of the head, to maintain visual fixation” (Kiernan, 1998, pp. 402-403).

When the head is accelerated, in any plane of movement, a compensatory motion in the opposite direction occurs within the eyes (Guyton, 1976, p. 267), caused by the vestibulo-ocular reflex (Kiernan, 1998, p. 403). This enables the retina to observe a steady image (Mohammad, Whitney, Marchetti, Sparto, Ward, & Furmann, 2011, p. 277) despite the presence of head movement (Guyton, 1976, p. 267). The reflex is present at birth (Rudduck, 2004, p. 3) and is reliant on the visual, proprioceptive and vestibular systems (Sağlam & Lehnen, 2014, p. 425).

Research found the GS test to be functional in the evaluation of the vestibular-ocular reflex (Honaker & Shepard, 2010, p. 361), and the test is also included in the revised COs (Cook et al., 2016).

Gilligan, Mayberry, Stewart and Gaebler (1981) investigated ocular movement of 489 typical children, aged three years to 10 years 11 months in order to provide normative data. They used an octagonal-shaped board with a moving star and placed it 60 centimetres from the participant’s head. The participants were asked to follow the moving star. Five behavioral characteristics were recorded: (1) general pursuits, (2) crossing midline, (3) bilateral movement of eyes, (4) range and (5) head movement. The results indicated that at six-and-a-half years, the skill to follow an object matures, younger girls performed better than boys, with the opposite found in the older age groups. General movement increases with practice as the child grows older and perfect scores in bilateral coordination of the eyes were obtained by 70% of the participants. A steep incline was seen in head movement, up until six years of age. Similar findings for range and crossing of midline were evident but less pronounced. This indicates that the neurological maturation of the three behaviours, head movement, range and crossing midline, are mostly completed at age six years (Gilligan et al., 1981, pp. 253-254).

Schärli, Van de Langeberg, Murer and Müller (2013) conducted a study on four age groups, six-, nine-, and twelve-year-olds, and a group of young adults aged between 18-35 years. The study investigated natural gaze and the influence thereof on postural control and typical development from childhood to adulthood.

The authors found that younger children, aged six years, have difficulty keeping their head stationary and present with body sway in a static stance when asked to watch an animated movie.

A decrease in head rotation, during the gaze tests, was seen in the older age groups. The researchers concluded this to be expected as postural stability increases with age (Schärli et al., 2013, p. 533). The study, however, did not include the five-year-old population. A study done by Flatters, Mushtaq, Hill, Rossiter, Jarrett-Peet, Culmer, Holt, Wilkie and Mon-Williams (2014, p. 1960) did include the five-year-old population and confirmed the findings of Schärli, et al. (2013). Their results supported that postural stability can be influenced by head movements and the ability and speed to visually track an object increases with age. Most importantly, GS does not seem to be fully matured by age five as found by most of the cited studies, necessitating a thorough description of what is to be expected of the five-year-old child.

Research is available with regard to the assessment of GS in typical adults (Honaker & Shepard, 2010 and Lee & Honaker, 2013). The studies respectively aimed at investigating the effect age has on GS (Honaker & Shepard, 2010) and how accurate GS can be measured using the GS test (Lee & Honaker, 2013). Both studies were administered in a well-lit room. A "head-mounted rate sensor" was placed on the participants' head. The participants were asked to move their head horizontally and vertically while fixating their eyes on a computer screen 3 meters from their chair. The studies respectively concluded that age should be taken into consideration when testing GS. Further research needs to be done in order to standardise a protocol for testing and to establish scores to identify impairments (Honaker & Shepard, 2010, p. 362 and Lee & Honaker, 2013, p. 84).

Kaufman, Puckett, Smith, Wilson, Cheema and Landers (2014) also investigated the reliability of the GS test in 50 males, 30 being college football players. They used the InVision System as a measurement instrument, which included static visual acuity and a perception time test. The participants were placed in a white wall room 10 feet from the computer screen. Their findings provided evidence that football players can maintain GS at a higher speed, but found the test's reliability moderate to poor.

Similar findings on the reliability of the GS test could be found in a study done by Mohammad et al. (2011). They also used the InVision device on 28 participants with known vestibular disease and found the reliability of the test poor to fair.

From available literature, it was evident that different protocols exist for testing of GS. In the revised COs (Cook et al., 2016) the child is seated and asked to fixate on an object, placed in the midline 30 centimetres from the child's face while moving the head vertically and horizontally. GS is not included in the work of Dunn (1981), Blanche (2002) or the currently used COs (SAISI, 2005), but the test is included in the revised COs (Cook et al., 2016).

It is known that smooth and coordinated eye movements are expected of the five-year-old child (Dunn, 1981, p. 4) and additional observations are available in Blanche's work (2002, p. 13) when assessing overall eye movements, however, none of which are specific to GS. Ayres (1972 in Gilligan et al., 1981, p. 251) also described additional observations that can assist the therapist in identifying ocular difficulties when assessing the child using COs. The author's observations included, the conclusion that losing or overshooting the target, inability to change direction with the eyes, moving the head rather than the eyes, making faces, blinking or squinting, inattentiveness, difficulty finding the object when asked to look away and trouble with midline crossing, can suggest possible SI difficulties. These observations are valuable, but again not age-specific. As observations of eye movements and GS can assist the therapist in making a SI diagnosis, further investigation is imperative in order to provide therapists with age-specific observations, to enhance the accuracy of assessment and interpretations when testing GS.

x) Standing Balance (SB) eyes open and closed

Balance refers to the body's ability to maintain an upright position against gravity. The integration of sensory processing from the vestibular, visual and proprioceptive systems is essential in controlling balance (O'Brien & Williams, 2010, p. 256) and a simple clinical test to assess the integrity of the mechanisms is to ask the individual to perform a balance task by keeping his eyes closed while standing still (Guyton, 1976, p. 147). The same procedure used by Guyton, as well as standing on one leg with eyes open, is described by Touwen (1979, pp. 68, 78) when assessing a child's neurological functioning.

A balance test is also included in the QNST (Mutti et al., 1998, pp. 29-28) and is similar to the one used in SI assessment, where the child is asked to maintain balance while standing on one leg and asked to repeat the action with closed eyes.

During a balance task, head motion activates vestibular impulses which contribute to the visual system to enable a stable visual field. This is done through the neural pathway starting at the vestibular labyrinth and moves through pathways of the spinal cord and brain stem, ending at the motor neurons in the cerebellum (Kiernan, 1998, pp. 396-397).

Within SI assessment, standing balance is not included in the COs (SAISI, 2005), but is included in the revised COs (Cook et al., 2016). Standing balance on one leg with eyes open and closed is also included in several standardised tests such as the SIPT (Ayres, 1989, p. 7) and Bruininks-Oseretsky Test of Motor Proficiency Second Edition (Bruininks & Bruininks, 2005). As both tests evaluate a series of balance tasks (Ayres, 1989, pp. 22-25 and Bruininks & Bruininks, 2005, pp. 6,21), a combined score for balance is obtained, thus the age norm for one area such as standing on one leg with eyes open and closed, on these two standardised tests, are not published.

According to Touwen (1979, p. 78), children aged five years can stand on one leg for approximately 10-12 seconds, with a distinct difference in the performance of the dominant and non-dominant leg. Thorpe (1975 in Mutti et al., 1998, p. 62) also found that children aged five years are able to balance on each foot for 10 seconds. The time norm of 10-12 seconds for five-year-old children (with six-month intervals) balancing on one foot with eyes open, is also included in the Occupational Therapy Association of South Africa (OTASA) screening tool (OTASA, 2009).

Touwen (1979) not only describes age norms but additional observations that can also assist the therapist in assessing balance in children. He found children under the age of six years, need toe and ankle movement without displacing the feet, in order to maintain balance, when eyes are closed. Body sway can also be expected, but Touwen (1979, p. 68) did not describe the specific age group.

Even though different assessment measures are available to test balance in children (Ayres, 1989 and Deitz, Richardson, Atwater, Crowe, & Odiorne, 1991) and an established age norm of 10-12 seconds exists, more descriptive observations, such as Touwen's (1979) are needed to assist the therapist in distinguishing normal and abnormal performance of five-year-old children while performing a balance task.

2.4.4 Concluding the COs

The COs have been proven to be a useful measuring instrument when assessing a child's sensory processing.

When comparing the COs as a measuring instrument against Ayres's description of a measuring instrument (cf. 1.1), the researcher found four areas of concern;

- The lack of assessing accurate parameters, as there is an absence of normative data on the COs (Parham & Mailloux, 2010, p. 352).
- Secondly, the assessment tool is not standardised, with different procedures for administration occurring between clinicians. As the COs also allows for a great deal of subjectivity and personal experience from the clinician (Parham & Mailloux, 2010, p. 352), this essential tool may not be used consistently.
- The COs have the potential to measure exact and precise behaviour, but currently, the typical performance of children performing the COs is unknown. Therefore, the performance seen cannot be fully understood, as we do not have sufficient evidence distinguishing typical from atypical behaviour.

As the literature review outlined the gaps in our knowledge, it is imperative that further research needs to be done on the COs to ensure more accurate assessment in future.

2.5 Section D: The South African research context

2.5.1 Context and early childhood

To gain a better understanding of the study population, the researcher needed to investigate the context of the five-year-old child, not only residing in Bloemfontein where the study was conducted, but also the broader SA.

SA has a diverse population of 55.9 million people (South African Government, 2017), with a racial distribution of 79.2% African-, 8.9% Coloured-, 8.9% White and 3% Indian/Asian people (Statistics South Africa, 2015, p. 22). Eleven official languages are recognised. The most commonly spoken is IsiZulu (22.7%), followed by IsiXhosa (16%), Afrikaans (13.5%) and English (9.6%) (South African Government, 2017).

The government strived to improve children's development by investing in early childhood development programmes. In 2015, the SAn cabinet approved a new policy, the "National Integrated Early Childhood Development Policy," with the focus on children between birth and six years of age (Hall, Sumba, Berry, Giese, Almeleh, & Rosa, 2016, p. 4). With the research population being five years of age and estimated in 2013 to be a population of 101 7316 (Statistics South Africa, 2013, p. 13), the policy has definite relevance to them. The policy states that services should be provided in five components, namely: maternal and child primary health, nutritional support, support for primary caregivers, social services and stimulation for early learning. A closer look into early learning is relevant as the research population attended Grade R.

Sixty-four percent of children in SA are enrolled in early learning programmes which includes day mothers, nannies, nursery schools and children attending Grade R (Hall et al., 2016, p. 27). These programmes are classified based on income quintiles (Q) ranging from Q1 (poorest 20%) up to Q5 (richest 20%). Q1-Q3 are seen as low socio-economic status (SES) while Q4-Q5 falls into the category of middle-high SES (Free State Department of Education, 2017).

SA consists of nine provinces, one being the Free State. The following statistics, provided in Figure 2.2, are based on children under six years of age living in the Free State, taking a closer look at the population, housing, poverty and education, factors important in gaining an overall view of five-year-old children included in this study.

Population	Housing	Poverty	Education
• Children under six years take up 5% of the population, • 32% of households have children under six years.	• 83% live in urban settings, • 11% live in rural settings, with the remaining living in farming areas.	• 66% live in poor households, <R923 pm, • 31% live in food-poor households <R397 pm, • 30% live in households with no employed adults. • 13% child hunger rate.	• 40 234 learners attend Grade R. • 611 ♀ and 616 ♂ attend independent schools. • 19 337 ♀ and 19 602 ♂ attend public schools. • 68 ♀ and 32 ♂ attend special schools.

Figure 2.2: Statistics of children under six years, living in the Free State (compiled from Hall et al., 2016, pp. 9-29 and Free State Department of Education, 2017).

The Free State is the third largest province in SA with several Municipalities, one of which is the Mangaung Metropolitan Municipality (Local Government, 2012-2017), further referred to as Mangaung Metro. Elaboration on the demographic information of the Mangaung Metro will follow.

The total population in 2011 was 747 431 and consisted of 77.8% Black Africans, 16.8% White, 5.2% Coloured and 0.2% Indian/Asian people. The population of children aged between 5-9 years was estimated as 32 930 males and 32 716 females (Statistics South Africa, 2011b, pp. 10, 47-48). The Mangaung Metro has an unemployment rate of 28% and high levels of poverty. The average household consists of 3.1 people (Local Government, 2012-2017) with a dwelling distribution of 83.7% formal, 14.1% informal and 1.3% traditional (Statistics South Africa, 2011a, p. 18).

Bloemfontein, among others, falls within the region of Mangaung Metro. It was decided to conduct the study on five-year-old children attending Bloemfontein schools, in order to limit traveling costs and to make the study feasible.

A closer look at five-year-old children's general school attendance in Bloemfontein for April 2017, revealed that at the time it was 5519. Table 2.5 illustrates the distribution of Grade R learners in April 2017 in Bloemfontein schools.

Table 2.5: School distribution of the Grade R population in Bloemfontein (compiled from Free State Department of Education, 2017).

	Public Schools	Independent Schools	Farm Schools	Hospital Schools
Grade R learners	4962	345	207	5

The researcher set forth the context in which the five-year-old child residing in SA, more specifically the Free State and Mangaung Metro, grows up. The following subsection will aim at describing how the environment influences the child's occupational performance skills.

2.5.2 Context and influence thereof on occupational performance

In the previous section, a variety of contextual information on SA, including cultural differences, educational enrolment, physical factors, housing and SES were the focus in order to gain an understanding of the five-year-old child's environment

Literature is replete of research examples viewing how culture influences a child's occupational performance with regard to motor development, values, self-concept, emotions, socialisation and play (Brazelton, Koslowski & Tronick, 1976; Danseco, 1997; Cote & Bornstein, 2005; Keller, 2012 and Chen & Eisenberg, 2012). Even though the research population included children from different cultures, for the purpose of this section, the researcher will focus on two prominent variables and the incluence therof on child development and occupational performance skills. The two variables are:

- *SES*, as children from both low and middle-high SES, were included in the study and
- *Education*, as children enrolled in pre-schools (mainly Grade R), from different Q-schools were included.

> *SES reflects a composite of different factors, including the social prestige of family members, educational attainment of the parents, and family income. These factors influence each other and have various implications for how a family fulfills its function, by influencing the degree of access that families have to activities and experiences for their children* (Jaffe & Cosper, 2015, p. 141).

Families from low socio-economic status (LSES) lack resources, such as housing, food, and transportation. Their functional views shift from engaging in activities and experiences to fulfilling basic needs (Case-Smith, 2015, p. 7). Brooks-Gunn, Klebanov and Liaw (1993) also believed that children from LSES do not have access to warm learning environments. They tend to be exposed to more violence and family conflict and are more prone to developmental delays (Van der Linde & Olivier, 2010, p. 15). Likewise, Brooks-Gunn, Dunca, Klebanov and Sealand (1993) found that poverty affects a child's physical environment and experience to learn, as found in their study done on low birth weight children aged three years. They also state that families of LSES, are more likely to be exposed to multiple risk factors of low birth weight, poor neonatal health, and unemployment, as found in their results (Brooks-Gunn et al., 1993, pp. 259-266). A SAn study conducted by Van Jaarsveld (2010, p. 13) indicated that children in lower socio-economic environments have occupational barriers and are prone to developmental delays.

On the contrary, high socio-economic status (HSES) can provide children with the prospects of learning (Jaffe & Cosper, 2015, p. 142), as the environment provides occupational opportunities (Haertl, 2010, p. 270), enhancing the child's occupational performance skills. However, children find themselves in a "technologically changing environment" (Hills, King, & Armstrong, 2007, p. 14). Children in SA, growing up in the middle-income category, have access to television (87.9%), computer (23.8%) and cell phones (92.9%). Children growing up in the high-income category have even more access to these electronics (televisions, 96.4%, computers, 79.5% and cellphones, 98.2%) (Statistics South Africa, 2011a, pp. 32-33). It is likely that these children might choose to rather engage in more sedentary play activities involving technology, which might influence their occupational performance (Case-Smith, 2010b, p. 60).

This can be supported by a study done in Chester on four- and five-year-olds. They found that as children spent an increased amount of time in front of screens, they did not engage in physical activities such as crawling, running, climbing, etc. It was apparent in the study that 30% of participants showed signs of immaturity with an additional 40% showing development delays. The study concluded that a lack of physical activities influences a child's academic skills and school readiness (Clark, 2012).

But, "due to a lack of comparable data, it is difficult to demonstrate that the level of physical activity in today's children is low compared with their counterparts several decades ago" (Hills et al., 2007, p. 15). Therefore, further research into the performance of children residing in both socio-economic environments is imperative.

A link also exists between SES, stunting and educational enrolment (Grantham-McGregor et al., 2007, pp. 60-61). Research indicated that stunted children are less probable to be registered in schools (Beasley et al., 2000 in Grantham-McGregor et al., 2007, p. 63) and these children's educational progress is poorer when compared to children of the same age who experience no stunting (Moock et al., 1986, Jamison, 1986, Clarke et al., 1986, Steegmann et al., 1992 and Shariff et al., 2000 in Grantham-McGregor et al., 2007, p. 63). Studies that were done nationally also indicated a correlation between poverty, school enrolment and achievement (Alderman et al., 1997, Behrman et al., 1999 and Filmer et al., 1999 in Grantham-McGregor et al., 2007, p. 64).

Children, however, do not only learn when they are enrolled in schools, as the home environment also allows for teaching opportunities. Unfortunately, the child's learning opportunities at home are also dependent on the SES and parents' educational levels. These factors influence the parents' quality of interaction with the child (Hoff, Laursen, Tardif, 2002 in Jaffe & Cosper, 2015, p. 142). In circumstances where parents have limited education or low SES, "parents may not be as responsive, addressing the child less often, providing fewer learning opportunities, and not engaging in an interactive teaching process" (Jaffe & Cosper, 2015, p. 142).

Concluding the literature review on the influence of the environment on a child's occupational performance, it became evident that context has an influence on children's occupational performance skills and developing countries are more likely to have more children from disadvantaged backgrounds (Grantham-McGregor et al., 2007). This highlights the need for scrutiny into the performance of SAn children from diverse backgrounds and socio-economic environments.

2.5.3 Concluding the literature review

The following summary is delineated as the core findings from the literature review, which led to the research question.

- Accurate assessment enhances effective intervention (Stewart, 2010).
- The SI frame of reference is valuable and used frequently in both paediatric assessment and intervention around the world, including SA (May-Benson & Koomar 2010; Yack 1989 cited in Wallen & Walker, 1995; Wallen & Walker, 1995; Van Jaarsveld et al., 2001 and Parham & Mailloux 2005).
- Children's performance on sensory processing assessment instruments differ (Van Jaarsveld et al., 2012; Van Jaarsveld et al., 2013 and Janse van Rensburg et al., 2013).
- COs can supplement and is a necessity when evaluating SI (Ayres, 1989 and Parham & Mailloux 2010).
- The COs is widely used amongst SAn OTs (Janse van Rensburg et al., 2017).
- The COs' norms are derived from US samples, which are currently used in SA (SAISI, 2005).
- No SAn norms are available. However, the COs (SAISI, 2005) are currently under revision to include more SAn norms (Cook et al., 2016). This document is in need of research on SAn children (Van Jaarsveld, 2016).
- Limited research is available describing age-related performance on the COs (SAISI, 2005). The expectations of a typical five-year-old child engaging in the COs (SAISI, 2005) subtests are unknown. This influences the accuracy of assessment as therapists cannot precisely measure and interpret the observed performance.

From the literature review, gaps were identified, highlighting the need for further research, and arguing the necessity of this study. The research methodology used to conduct the study will be described in Chapter 3.

CHAPTER 3

Research approach and method of research

3.1 Introduction

Chapter 2 provided an overview of the relevant literature related to this study, with a focus on the Clinical Observations (COs) and the ten identified subtests. The demographic information of South Africa (SA) and Mangaung Metro, where the study was conducted, were also investigated. Lastly, the influence of the environment on a child's occupation was considered.

From the literature review, it was evident that the use of the COs assessment tool is relevant in SA to assess Sensory Integration (SI) difficulties. However, the norms currently in use have not been researched on the South African (SAn) population. Discrepancies do occur in the performance of SAn children and children residing in the United States (US), putting into question the fairness and accuracy with which therapists interpret the findings of the COs when used on SAn children (cf. 1.1).

In this chapter, the method of research with regard to the study design, research participants, sampling method, measurement instrument and procedure are presented. Measurement and methodological errors, as well as ethical considerations applicable to the study, are described, followed by a conclusion to end Chapter 3.

3.2 Method of research

3.2.1 Study design

A quantitative, descriptive observational study design was used to describe the performance of five-year-old children while executing the ten items of the COs. A descriptive study design "is crafted to gain more information about characteristics within a particular field of study… to provide a picture of situations as they naturally happen" (Burns & Grove, 2009, p. 237).

This allows the researcher to (1) objectively observe the prevalence of characteristics at a given time (Joubert, Bam, & Cronjé, 1999, p. 16) and (2) to quantify the observed behavior, through computing the characteristics as it occurs and to determine the frequency thereof (Grosser, 2016, p. 284). With this study design, the participants are not provided with any form of intervention (Burns & Grove, 2009, p. 238). The descriptive observational study design allowed the researcher to individually observe the natural performance of five-year-old children while executing the ten COs items, thus, identifying specific performance, without providing any intervention.

The researcher made use of a "value scale," also known as the "magnitude recording," to record the measurable characteristics of each COs item, with regard to a grade scale, based on the intensity, frequency and overall performance of the participants (cf. Appendix I and 3.2.4.1). According to Delport and Roestenberg (2011, p. 184) "this form of recording involves frequency, severity or level ratings of behaviours." The researcher also recorded the *observed performance*, making a mark next to the performance once it is observed in the participants. This allowed the researcher to identify the observable characteristics present during each CO item (cf. 3.2.4.1).

As limited research has been done on the performance of five-year-old children on the COs, the design used was suitable, as it is a "critically important design for acquiring knowledge in an area in which little research has been conducted" (Burns & Grove, 2009, p. 238).

To answer the sub-aim of the study with regard to the socio-economic (SE) differences, a cross-sectional study design was utilised. According to Burns and Grove (2009, p. 241), a cross-sectional design "examine[s] groups of subjects in various stages of development, trends, patterns, and changes simultaneously with the intent to describe changes in the phenomenon across stages." The participants are then categorised into groups (Burns & Grove, 2009, p. 241). For this study, the researcher wanted to investigate if differences in the performance of children on the ten chosen COs subtests, enrolled in low and middle-high SE schools, do occur.

The participants were grouped according to their school's socio-economic status (SES), and the performance of two groups was compared.

As previously stated in chapter 2 (cf. 2.5.1), the Free State Department of Education (FS DOE) classifies schools in SE groups or quintiles (Q). Q1-Q3 are the so-called "no school fees" schools, where the parents do not pay school fees and are seen as low SE schools. Q4-Q5 are schools where the parents do pay school fees and are seen as middle-high SE schools.

3.2.2 Study population

The study was conducted on a heterogeneous group of 120 typically developing five-year-old children, ranging from five years six months to five years eleven months old, from diverse SE backgrounds, attending Grade R in public pre-schools in Bloemfontein, Mangaung Metro District. Five-year-old grade R learners were chosen as the focus of the study, as they are in the preparation phase for attending formal schooling and early identification of problem areas through assessment will contribute to early intervention (Case-Smith 2010, pp. 74-75). In addition, Grade R learners represent a large part of occupational therapists' (OTs) client population. A recent study by Janse van Rensburg et al. (2017) found that 92.50% of SAn OTs in paediatric practice treat pre-schoolers aged between four and six years.

The inclusion of participants from diverse SES in the study made it possible to compare the performance of the participants enrolled in low and high SE schools, to conclude if discrepancies in the performance on the COs occurs between the two groups.

Considering the fact that the researcher resided in Bloemfontein, the research was conducted in the Mangaung Metro district. Public pre-schools were chosen to provide the researcher with an official classification of SES as done by the DOE. The five-year-old population and context where the study took place were thoroughly described in section 2 (cf. 2.5.1).

a) Inclusion and Exclusion Criteria

Both the schools and study population had to comply with the following inclusion and exclusion criteria.

The *pre-schools* were considered eligible for inclusion in the study if they:

- Present Grade R and were registered with the DOE or follow the DOE curriculum;
- Were located within a 30 km radius from the University of the Free State (UFS), due to feasibility with regard to traveling costs.

Pre-schools were not included in the study if they;

- Had less than 30 children enrolled in Grade R. The researcher wanted to include schools that would provide the study of an adequate number of participants when visiting the school. This ensured the researcher would have a representative sample of the school.
- Did not allow for execution of research between January - March 2017.

The *participants* were considered eligible for inclusion in the study if they:

- Were between five years six months and five years eleven months of age;
- Were from any cultural and SE background;
- Were attending a pre-school that met the inclusion criteria as stipulated above at the time of execution of the study.

Participants were not included in the study if they;

- Had previously received occupational therapy (OT), physiotherapy and/or speech therapy intervention;
- Had any diagnosed disabilities including hearing, visual, physical and cognitive disabilities;
- Were diagnosed with any medical condition(s)/pathologies;
- Were on medication for diagnosed conditions such as Attention Deficit Hyperactivity Disorder and epilepsy.

This allowed the researcher to include typically developing children, with no known diagnoses or developmental delays (cf. 3.2.3 b).

3.2.3 Sampling method

Sampling, according to Polit and Beck (2006, p. 260) "is the process of selecting a portion of the population to represent the entire population", where the researcher decides the type of study, composition of the sample and lastly what type of method will be used (Lombard, 2016, p. 95). The sampling method chosen by the researcher for the pre-schools and participants will now be discussed.

a) Schools

Ethics clearance was obtained from the Health Science Research Ethics Committee (HSREC) of the UFS (164/2016), and permission was obtained from the FS DOE (Appendix A) to conduct the study. The researcher acquired a list of schools from FS DOE's Educational Management Information System (EMIS) for schools located in the Mangaung Metro district. The list included each school's Q classification as well as the number of children enrolled in each grade. The researcher eliminated the schools from the list that did not meet the inclusion criteria as stipulated in 3.2.2 a.

From the remaining schools that adhered to the inclusion criteria, two lists were drafted on Microsoft Excel (Lombard, 2016, p. 97). The first list contained 35 low SE schools (Q1-Q3) and the second list consisted of 23 middle-high SE schools (Q4-Q5) (see Table 3.1). The researcher made use of stratified random sampling (Burns & Grove, 2009, p. 350) to select schools from both quintile groups, to participate in the study. Stratified random sampling allows for clustering of groups or variables in order to enhance the representativeness of the sample (Polit & Beck, 2006, p. 265 and Burns & Grove, 2009, p. 350), and according to Burns and Grove (2009, p. 350), one of the most commonly used variables chosen for stratified random sampling is SES.

The following table illustrates the selection of the schools through the stratified random sampling process, to form part of the study. The process followed is described after the table.

Table 3.1: Selection of the schools through stratified random sampling (compiled by the researcher).

	Quintiles (Q)	Schools adhering to the criteria	Schools selected	Schools declining research	Schools included in the study
Low socio-economic status (LSES)	1		-	-	0
	2	35	2	0	0
	3		6	0	3
Middle-high socio-economic status (HSES)	4	23	3	1	2
	5		5	1	3
					8

For the *low SE schools*, none of the Q1 schools adhered to the inclusion criteria (e.g., not within a 30km radius from UFS or did not have a Grade R class) and could, therefore, not form part of the sample list. After Q1 schools were eliminated on the EMIS list, the list was sent to the Department of Biostatistics at the UFS, to randomly select schools for inclusion in the study. The list was received back, and the schools randomly selected, were highlighted in green. Two schools from Q2 and six schools from Q3 were selected. The researcher worked systematically from top to bottom, phoning the first school on the list. None of the schools declined participation in the research. The researcher approached the schools (systematically according to the list) in January 2017 to formally obtain consent. Three Q3 schools were able to immediately accommodate the researcher. One Q2 school was only able to accommodate testing of the participants at the end of February. The researcher found it difficult to make an appointment with the principal from the remaining Q2 school and decided to start with the Q3 schools who had already given permission. The researcher was able to reach the study population for the low SE group with the use of the three Q3 schools and did not approach the remaining schools on the list.

For the *middle-high SE schools*, three Q4 and five Q5 schools were selected. One school from each quintile declined to participate in the research study, and the researcher approached the next school on the sample list. The researcher used the same systematic process as described for the low SE schools, approaching schools on the list from top to bottom, and obtained the required study population for the middle-high SE group, with the assistance and compliance of two Q4 and three Q5 schools.

The schools selected through the stratified random sampling process as described above were approached with the information document and consent form (cf. Appendix B) in the fourth school term in 2016, to gain preliminary permission to conduct the study. After obtaining permission from the schools, the process for selecting the participants started.

b) <u>Participants</u>

After obtaining permission from the school principals, the following process was followed to obtain the required sample of participants from the study population.

The researcher visited the first selected school on the sample list and approached the Grade R classroom educators. The study was explained, and the educators were asked to identify participants in their class who, to their knowledge, met the inclusion criteria (cf. 3.2.2 a). The educators drafted a sample list with the names and dates of birth of the participants that adhered to the inclusion criteria. The researcher prepared and delivered an envelope for each identified participant which contained a parent/guardian information document and consent form (cf. Appendix C). The forms were available in Afrikaans, English, and Sesotho and classroom educators were consulted regarding the language preferences of the parents in order to place the appropriate documents in the envelope. The information document (cf. Appendix C) served to introduce andorientate the parents/guardians regarding the aim of the study, risks involved, population required, expectations from the parents/guardians as well as the participants, the assessment and language of execution, confidentiality, remuneration, voluntary participation, feedback, publication of the results, ethical principles and the researcher's contact information. An informed consent form accompanied the information document and had to be completed by the parents/guardians. In addition to informed consent, the form also included five short questions that were completed by the parents/guardians, to assist the researcher in identifying participants who received therapy, were taking medication and/or had been diagnosed with any medical condition, as these participants were excluded from the study (cf. 3.2.2 a).

The classroom educators distributed the envelopes to the identified participants and reminded the parents to return the envelopes to the school within a week. After the week passed, the researcher collected the envelopes. The researcher scrutinized and sifted the completed forms to identify participants meeting the inclusion criteria, wherefrom the researcher drafted a list with the participants' names, dates of birth, gender and age in years and months to be tested at the school (cf. Appendix F).

The researcher telephonically made arrangements with the principal, and/or Grade R classroom educators to test the participants. The arrangements included, the date, time and venue of testing and the schools were reminded telephonically a day before the testing.

The researcher repeated this process with each school on the sample list. Eight schools were included in the final study sample in order for the researcher to reach the required study population of 120 participants. Table 3.2 summarises the study sample composition in terms of schools, gender, and SES.

Table 3.2: Summary of study sample composition (compiled by the researcher).

	Q	Schools	Boys	Girls	Total
LSES	1		-	-	-
	2		-	-	-
	3	1	6	5	11
		2	11	14	25
		3	13	11	24
			30	**30**	**60**
HSES	4	1	8	5	13
		2	7	6	13
	5	1	-	12	12
		2	8	4	12
		3	7	3	10
			30	**30**	**60**

3.2.4 Measurement

Measurement, according to Polit and Beck (2006, p. 323), involves measuring the variables in order to establish quantities. Measurement is described according to the measuring instrument, data collection, data analysis and measurement and methodological errors.

3.2.4.1 Measurement instrument

Within quantitative data collection, a measuring instrument "refers to such instruments as structured observations schedules, structured interviewing schedules, questionnaires, checklists, indexes and scales" (Delport & Roestenberg, 2011, p. 171). The researcher made use of structured observations through the use of an adapted COs measuring tool (cf. Appendix G).

As described in the literature study, the ten chosen subtests can be found in both the existing COs (SAISI, 2005) and revised COs (Cook et al., 2016). Therefore, both documents were used to compile an adapted version COs form for this study. The adapted version COs form included a number allocated to each participant, gender, SES and the ten chosen subtests. For each subtest, measurable and observable characteristics were recorded.

The *measurable characteristics* served as a rating scale, observing the occurrence and quality of the participant's performance (Polit & Beck, 2006, p. 309). A five-point scoring scale was used, as found in the revised COs (Cook et al., 2016) and the participant was scored according to the overall performance on the test. In addition, other measurable characteristics applicable to the specific item, such as a number of repetitions, duration in seconds or degree of postural changes were also recorded. The measurable characteristics' grade score was subjective and very vague. Therefore, the researcher added more specific guidelines as to when a certain grade score could be allocated (cf. Appendix I). These guidelines were compiled before the execution of the study and remained unchanged during the course of the study. Table 3.3 below includes an excerpt of the measurable characteristics of the Standing Balance test. A comprehensive description of each COs item's measurable characteristics is included in Appendix I.

Table 3.3: Example of grade score allocation of Standing Balance test (compiled by the researcher).

Allocation of grade score eyes open	Allocation of grade score eyes closed
Grade 1: Stand on one leg for 1-2 seconds.	Grade 1: Stand on one leg for 0-1 second.
Grade 2: Stand on one leg for 3-4 seconds.	Grade 2: Stand on one leg for 2-3 seconds.
Grade 3: Stand on one leg 5-7 seconds.	Grade 3: Stand on one leg for 4 seconds.
Grade 4: Stand on one leg for 8-10 seconds.	Grade 4: Stand on one leg for 5 seconds.
Grade 5: Stand on one leg for more than 10 seconds.	Grade 5: Stand on one leg for more than 6 seconds.

The *observable characteristics* were split into two columns – a 'should have' parameter (SH) and a 'should not have' parameter (SNH) column. The SH parameters included performance characteristics the researcher assumed should be present, and the SNH parameters included performance characteristics the researcher assumed should not be present while executing the tests. Each subtest had its own SH and SNH parameters, and these parameters were chosen based on literature (cf. 2.4.3) and clinical experience.

The observable characteristics column served as a checklist to record the observed performance (Polit & Beck, 2006, p. 309) for each item. Each time the performance occurred, the researcher made a mark next to the relevant performance. Table 3.4 below includes an excerpt from a marked example of the Standing Balance test item. A comprehensive description of each COs item's observable characteristics (SH and SNH Parameters) is included in Appendix L.

Table 3.4: Example of marked observable characteristics of Standing Balance test (compiled by the researcher).

	Eyes open		Eyes closed	
SH PARAMETERS	**Right leg**	**Left leg**	**Right leg**	**Left leg**
Maintain arms in sides	X		X	
SNH PARAMETERS				
Body sway	X	X	X	X
Asymmetry				
Bracing against leg	X			
Use vision to look at feet				
Eyes or head not steady				
Shift supporting foot	X		X	
Exaggerated movements of arms and trunk			X	X
Toe and ankle movement without displacing the feet	X	X	X	X
Anterior tilt of pelvis	X			
Grabs onto clothes				X
Associated reactions with mouth				
Shoulder elevation	X			
Fixating body		X		X

The observable characteristic column was compiled before the execution of the study, with the assistance of relevant literature, the researcher's available knowledge, practical experience and the execution of the pilot study. However, during the study, the researcher came across seven "new" performances not yet included in the measuring instrument but observed during the execution of the tests. These performances were added to the adapted COs measuring instrument during the course of the study. The researcher made sure the "new" performance (observable characteristics) did not occur in or were recorded for, the participants previously assessed by re-watching the specific subtest's performance of the already tested participants' video recordings.

The time required for the administration of the ten items per participant was approximately 20-30 minutes. Each participant was evaluated and scored on the adapted COs form (cf. Appendix G). The COs (SAISI, 2005) administration and interpretation booklet, Dunn's (1981) guide and the revised COs (Cook et al., 2016) were used as a guideline for executing the tests, as it provided the examiner with guidelines related to the equipment needed, positioning requirements and administration and scoring detail for the tests (cf. Appendix I for the specific procedures employed during this study).

3.2.4.2 Data collection

The collection of data is a precise, systematic process of gathering information, in line with the research objectives (Burns & Grove, 2009, p. 43). Data were collected at eight schools with the use of an adapted COs measuring instrument (cf. 3.2.3), observing and recording both measurable and observable characteristics present in the participants (cf. 3.2.4.1). The participants were video recorded for detailed analysis, and scoring was done *in vivo*, recording the results as the participants perform the action, as well as re-assessing the videos afterward. A detailed discussion on the data collection process will be covered in this section, taking a closer look at the different data collection stages, namely the logistics of data collection, pre-testing phase, testing phase, termination phase and data management and quality control phase.

a) <u>Logistics of data collection</u>

The data was collected between January and March 2017, in the mornings, from 08h00-13h00. The researcher tested seven or eight participants per morning. The researcher was responsible for testing ninety-three (93) participants, with the remaining twenty-seven (27) tested by one assistant, due to the limited time available. The researcher and assistant were competent test administrators, both additionally trained in sensory integration assessment and intervention, with four years' experience in paediatric OT. The assistant was trained in the use of the adapted COs form by the researcher (cf. 3.2.4.4 b). When referring to the researcher in subsequent sections, it also implies the assistant.

Administration of the COs occurred in a room at each school as allocated by the principal and/or classroom educators. One translator was used throughout the study. The translator was trained by the researcher and was given an information document and consent form (cf. Appendix E).

The translator was used in cases where the participants did not understand Afrikaans or English and the instructions were then presented in Sesotho.

b) Pre-testing phase

Prior to the testing, the researcher prepared the setting. This included arranging the participants' information document, and assent form (cf. Appendix D) and the participants' allocated number on the table, setting up the video camera, structuring the chairs, equilibrium board, goniometer, stopwatch and figure needed for testing of gaze stability. The researcher collected the participant at the classroom and introduced herself to the participant. The participant was taken to the test area, where the information document was explained. The participant was required to mark (X) the "smiley face" on the assent form (cf. Appendix D), if the participant provided assent to participate in the study. None of the participants refused to participate in the study.

c) Testing phase

The participant was asked to take off his/her shoes and was seated on the chair. The researcher made sure the video camera had a clear picture of the participant and started the video recording. The participant was asked to show the allocated number to the camera, and the researcher verbally repeated the number aloud. This was done for the purpose of data analysis. As no individually identifiable information (such as the participant's name) was recorded on the adapted COs form, the researcher had to allocate a number to the participant, to ensure the adapted COs form corresponded with the correct video recording, when the videos had to be re-assessed. The number was taken from the participant, and the first subtest of the COs was explained to the participant. The COs were administered in the following sequence: Diadokokinesis (DDK), Thumb-Finger touching (TFT), Equilibrium reactions (ER), Prone Extension Posture (PEP), Asymmetrical Tonic Neck Reflex (ATNR) and Reflex Inhibiting Posture, Symmetrical Tonic Neck Reflex (STNR), Supine Flexion Posture (SFP), Schilder's Arm Extension (SAE), Finger-To-Nose (FTN), Gaze Stability (GS) and ended with Standing Balance (SB).

As previously stated (cf. 3.2.4.1 and Appendix I) a set procedure was used with clear instructions to orientate the participant towards the procedure.

When a subtest required a more close-up image of the participant, such as when administering the GS subtest, the researcher adjusted the video camera by zooming in on the participant before giving the instruction for the subtest.

While the participant executed the first subtest, the researcher (1) observed the performance and wrote down the numerical values for the measurable characteristics (only applicable for some subtests), (2) made a mark (X) next to the SH and/or SNH parameters observed in the participant, and (3) allocated an overall grade score to the participants' performance. This process was followed until all 10 subtests were completed.

d) Termination phase

After administering all the subtests, the video recording was stopped, and the participant was thanked for his/her participation and given a sticker. While the participant put his/her shoes back on, the researcher completed the parent/guardian feedback letter (cf. Appendix J), making sure all the subtests have been marked and if necessary, wrote additional comments and/or referrals for an in-depth OT evaluation and/or referral to specific health services. At the beginning of the letter, the researcher marked if she was concerned or satisfied with the participant's performance on the ten subtests based on clinical judgment and existing knowledge of the COs as published in SAISI (2005). The letter was placed in an envelope and taken with the participant back to the classroom. The envelope was placed in the participant's backpack in class to be taken home to the parents/guardians. This process as described in (cf. 3.2.4.2 b, c, and d) was repeated for each child.

e) Data management and quality control

The video recordings were transferred to a password-protected computer located at the Departmental Occupational Therapy Private Practice at the UFS as well as an external hard drive, immediately after each morning's testing. The video recordings were deleted from the video cameras. Each child's video recordings were then re-assessed by the researcher ensuring detailed analysis. The measurable and observable characteristics were clearly examined on the video recordings and compared with the participant's initial COs scoring sheet. In cases where differences occurred between the child's initial form and the re-scoring, the recording was replayed, and observed by the researcher more than once. The researcher then made use of her clinical reasoning to make a final conclusion about the performance.

The researcher drafted a data scoring document in MS Excel (cf. Appendix K), comprising of 10 different sheets (a sheet for each COs subtest). The first sheet had additional columns for the child's allocated number, date of birth, gender, SES, and hand dominance. Each sheet was clearly marked with the COs subtest name and had a column where the participant's number had to be re-entered. Each sheet had marked columns for the measurable characteristics (grade score and numerical value) and marked columns for each subtests' SH and SNH parameters. The SH and SNH parameters were clearly distinguished from another by using colors and were separated by open columns. This made the data transfer process easier and more user-friendly.

Each child's COs adapted form (cf. Appendix G) had a corresponding "code" next to the SH and SNH parameters, the same code used for a column heading, making it easier for the researcher to transfer the data. Each child's data was transferred onto the scoring sheets, and if a SH and SNH parameter was observed, a number 1 was typed into the row. If the parameter was not observed, the row was left empty. The researcher transferred all 120 participant's data onto the sheet. The researcher reviewed the data after each participant's findings had been recorded on the spreadsheet to minimize data transfer errors as a method of data quality control. A copy of the spreadsheet was submitted electronically to the Department of Biostatistics for data analysis.

3.2.4.3 Data analysis

After obtaining the data from the data collection process, the data needs to be analysed and interpreted (Le Cordeur, 2016, p. 176). Data in quantitative research can be given through descriptive statistics (Le Cordeur, 2016, p. 176) "to synthesise and describe data" (Polit & Beck, 2006, p. 352).

The study made use of descriptive statistics, namely medians, frequencies and percentages for the categorical data. The data was not evenly distributed, which informed the use of non-parametric statistics. For the measurable characteristics, time in seconds or duration in movements, the median was computed. For the measurable characteristics, grade scores, as well as the observable characteristics, frequency procedures, and percentages were used.

To compare the variables for the two SE groups, a common procedure known as the t-test was used (Polit & Beck, 2006, p. 370). The t-test tests if significant differences between the means of two groups occur (Polit & Beck, 2006, p. 370). Significant differences were determined when the *p* values were less than 0.05 (Polit & Beck, 2006, p. 370). This value is based on the 95% confidence interval.

3.2.4.4 Measurement and methodological errors

Measurement error is the difference between the obtained and true scores and reflects the factors that influence the measurement and interfere with the results (Polit & Beck, 2006, p. 324).

According to Joubert et al. (1999, p. 47), three components are involved in the measuring process: the researcher, the participants and the measuring instrument, and measurement errors can occur in all three of the components. The measurement and methodological errors for this study will be discussed according to the three components involved in the measuring process, as described by Joubert et al. (1999, p. 47).

a) Participants

- The school's SES might not have been a reflection of the participant's SES. This measurement error cannot be controlled, but was limited as the researcher randomly selected schools per SES and more than one participant per school participated in the research.
- According to Burns and Grove (2009, p. 372), random error can occur due to (1) personal factors such as hunger, fatigue, health, mood, motivation and (2) situational factors referring to the room temperature, distractions, and seriousness of the situation. These factors can influence the participant's performance. The researcher attempted to minimise these random errors through firstly consulting with the classroom educator(s), making sure the participant was in a stable mood (e.g., the participant's behaviour and the mood are similar to the teacher's daily experience of the participant) before escorting him/her to the test area. Secondly, the researcher used her judgment and clinical experience to terminate and reschedule the evaluation if external influencing factors such as hunger, mood, motivation and fatigue were observed. The participants were allowed to bring their own water or cooldrink into the testing room. With regard to situational factors, the researcher attempted to minimise the errors through testing the participants at the school in rooms familiar to them. The rooms had limited distractions, and when necessary, a fan was used to cool down the room prior to and during testing. The researcher attempted to make the evaluation playful, by using terminology such as "let's see if we can fly" and gave the participant a "high five," to keep the participant's attention and decrease stress levels. None of the evaluations were terminated due to personal and/or situational factors.

b) Researcher and data collection process

- Random error can exist in the assessment process, as the participant's observed performance and allocated score might not be a reflection of their true ability (Burns & Grove, 2009, p. 372), due to an error in the researcher's assessment. It is possible that the researcher overlooked certain characteristics present in the participants. In addition, the observations are subjective. Therefore, an external assessor might have scored the participant's performance differently. The researcher attempted to minimise systematic error through the following: (1) The participant's video recordings were re-assessed by the researcher in addition to the *in vivo* scoring done during testing. If differences in allocated scores were observed, the researcher re-watched the action and used her clinical experience and reasoning to make a decision about the performance to ensure the most accurate score was allocated. (2) The researcher attempted to make the criteria for allocating a grade-score for each subtest more objective by describing specific performance criteria for each subtest (cf. 3.2.4.1 and Appendix I). (3) Intra-rater reliability was also calculated. The researcher re-assessed 10% of the videos blindly two months after initial data collection, in order to calculate the researcher's consistency in scoring the participants. The Simple Kappa Coefficient statistics were used as a measure of agreement to assess intra-rater reliability. The kappa results of all 10 COs items, were 1.000, indicating "an almost perfect agreement" (McHugh, 2012, p. 279). (4) The researcher has 4 years' experience in paediatric practice and as previously stated, completed her training in Ayres SI through the South African Institute for Sensory Integration (SAISI). The Ayres SI courses allowed for training in accurate assessment and interpretation of the observed performance. This also enabled more detailed observations.

- As previously mentioned (cf. 3.2.4.2 a), an assistant assessor assisted the researcher in testing 27 participants. This could have resulted in variations in administration affecting the obtained scores (Polit & Beck, 2006, p. 324). Variation in scoring was minimised by training the assistant to use the adapted measuring instrument. Training included both verbal instruction and *in vivo* training where the assistant observed the researcher in the administration and scoring of the adapted COs on a participant. Afterward, the researcher explained to the assistant why and when to mark the performance as well as when to stop the action. The assistant was also provided with the instructions (cf. Appendix I), and she was also trained in Ayres SI. The 27 video recordings, administered by the assessor, was re-assessed by the researcher. The same protocol for marking the videos as described above (cf. 3.2.4.4 b) was followed, and the researcher compared each participant's completed COs with the video recordings.

- It is possible that the instructions translated into Sesotho could have been different from the researcher's exact words, which could have influenced the participants understanding and execution of the actions. The researcher limited the error as only one translator was used throughout the execution of the study. The translator was informed of his role to translate only the researcher's exact words and was trained in the instructions to be given by the researcher before the participants were tested.
- Error could have occurred during the processing of data, accidentally pressing the wrong key and/or entering data in the wrong column (Burns & Grove, 2009, p. 372). A data quality control system was put in place by the researcher (cf. 3.2.4.2 e).

c) Measuring Instrument

- Limited research is available on the validity and reliability of the COs. The researcher attempted to increase the reliability of the test items on the adapted form through the pilot study (cf. 3.2.4.5). Data collected from the pilot study was assessed (e.g., types of observable characteristics present in participants from the pilot study) by an external observer and the researcher. This data was used to revise the observable characteristics.
- It was the first time the adapted COs was used as a measuring instrument. Therefore, no previous research has been done using this adapted form. However, the measuring instrument was adapted from the current COs (SAISI, 2005) and revised COs (Cook et al., 2016). The adapted measuring instrument included relevant literature as well as a wide variety of possible observable characteristics that might appear during the performance of the ten subtests. The researcher was also clear in understanding all the subtest's observable characteristics (cf. Appendix L) and knew what to look out for, as she consulted literature to include the parameters in the observable characteristics column. This ensured consistency in marking the observed performance.

  In addition, the measuring instrument (cf. Appendix G) was user-friendly, making it easy to administer and complete the document.

3.2.4.5 Pilot study

A pilot study determines the feasibility of the project, shows probable errors that may occur and can indicate possible findings to be expected (Joubert et al., 1999, p. 54).

The researcher performed the pilot study in the fourth term of 2016. As FS DOE did not allow research in schools during this term, one independent school was approached for the pilot study. A pilot study usually includes between five and ten participants (Joubert et al., 1999, p. 54). The pilot study for this research included seven participants, five girls, and two boys, ranging from five years six months to five years eleven months. The school adhered to the same inclusion criteria (cf. 3.2.2 awith the exception of being registered with the DOE or following the DOE curriculum. The participants needed to adhere to the same inclusion criteria set out for the study (cf. 3.2.2 a).

For the pilot study, the researcher had a first draft of the adapted COs (cf. Appendix H). This form also included general information such as the participant's number, date, gender and date of birth. Each subtest had an observable and measurable characteristics column. However, no clear SH and SNH parameters existed at that stage.

The same information documents, consent and assent forms were given to the school principal, parents/guardians and participants as in the main study (cf. Appendix B-D). The researcher tested the participants with the first COs draft at the school, and the measurement procedure (cf. 3.2.4.2) was kept unchanged. Afterwards, the video recordings were viewed by the researcher and an external assessor to analyse the performance of the participants. During the analysis, the researcher and assessor decided to refine the measurement instrument (Burns & Grove, 2009, p. 44). It was decided to "split" the observable characteristic column into the SH and SNH parameters. This not only allowed the measurement instrument to be more user-friendly, but also allowed the researcher to describe her findings in more detail according to the presence of these parameters. The observable characteristic column was also expanded as the researcher observed performances not listed in the column. The pilot study also assisted the researcher with practical arrangements, such as where the camera should be positioned, when to zoom in with the camera, establishing the approximate duration of testing per participant (20-30 minutes) and determining the number of participants the researcher could test per day, during the execution phase.

3.3 Ethical considerations

"Ethics is the branch of philosophy that deals with morality …it is a means of striving for rational ends when others are involved… These ends reflect respect for the other person" (Burns & Grove, 2009, p. 61).

As a result of historical human right violations in biomedical research, a variety of ethical codes were established, and this was done over different professions (Polit & Beck, 2006, p. 84). Polit and Beck (2006, p. 85) highlight that each discipline has its own code of ethics. In OT, the Occupational Therapy Association of South Africa (OTASA) Code of Ethics and Professional Conduct (World Federation of Occupational Therapy, 2005), addresses five important areas OTs are responsible for upholding professional behavior. These are:

- Responsibility towards clients/patients and their care providers,
- Responsibility towards colleagues,
- Responsibility towards the community,
- Responsibility towards the profession and self and
- Responsibility towards the professional body.

Striving towards this ethical professional conduct, the researcher adhered to strict ethical principles as outlined in documents such as the Declaration of Helsinki and universal ethical principles (Burns & Grove, 2009, p. 185 and Polit & Beck, 2006). Table 3.5 indicates the different ethical principles used and during what stage of the research they were applied.

Table 3.5: Ethical principles applied to the study (compiled by the researcher from Burns & Grove, 2009, pp. 191-204; Polit & Beck, 2006, pp. 87-91, 97; Janse van Rensburg, 2015, pp. 94-98; Creswell, 2013, pp. 56-59 unless otherwise specified).
Table adapted from Creswell, 2013, pp. 58-59 and Janse van Rensburg, 2015, pp. 95-98.

Stage of Research	Ethical principle	Strategy to adhere to principle
Planning phase	According to *The South African National Health Act* (2003, p. 76), a study involving human partakers must be approved by a health research ethics committee.	Ethics approval for the research was obtained from the HSREC from the UFS (164/2016) (cf. Appendix A).
	Obtain permission from relevant authorities involved.	Permission was obtained by the FS DOE to execute research at the schools (cf. Appendix A). School principals where the study was conducted were asked for approval, by signing permission letters (cf. Appendix B). These letters were submitted to the HSREC for final ethics clearance.
Pre-execution phase	When research is performed with minors, informed consent must first be obtained by the parents/guardian then assent from the participants.	Parents/guardians were provided with an information document and consent form (cf. Appendix C), prior to the research study. The names of participants whose parents/guardians gave permission, were listed and only they received assent forms (cf. Appendix D).
	Competency of the parties to fully understand the benefits and risk involved before giving consent.	All the relevant documents were available in Afrikaans, English and Sesotho. As previously stated (cf. 3.2.3 b), the classroom educators were consulted as to what the preferred language is of both the parents/guardians and participants. Therefore, the documents were available in the participant's language of choice, written in lay terms.

(Table 3.5: Ethical principles applied to the study – continued)

Stage of Research	Ethical principle	Strategy to adhere to principle
Pre-execution phase (continued)	Participants have the right to full disclosure.	The purpose and nature of the study, as well as the research process, was clearly explained to all the parties involved through the information document. It was also clearly stipulated in all the forms that the participants would be video recorded. Full disclosure was given to the parties involved with regard to the reason, what would happen to the video recordings, who has access to the recordings and when the recordings would be discarded. The document also included the researcher's contact details, should the parties involved have further questions about the research.
	Self-determination, where the parties involved have the right to (1) voluntary consent and (2) withdraw from the study.	The study was voluntary and the schools, parents/guardians, and participants were allowed to refuse participation in the study as well as to withdraw from the study without experiencing any disadvantages. This was clearly stipulated in the information documents. The participants were also provided with two faces which they could mark to either decline or participate in the study in the assent form.
	Non-maleficence. The researcher has a duty towards the participants to prevent harm.	The study caused no harm to the schools, parents/guardians, and participants of the study.
	Remuneration. The parties involved in the research, have the right to know if remuneration is available.	No parties received any remuneration. This was clearly stipulated in the information documents.

(Table 3.5: Ethical principles applied to the study – continued)

Stage of Research	Ethical principle	Strategy to adhere to principle
Execution phase	Preventing discomfort for the schools, parents/guardians, and participants.	*Logistical arrangements:* Each school was asked to provide a room in which the study could be executed to eliminate additional costs and arrangements from the parents/guardians such as traveling to a research site. The researcher liaised with the school and classroom educators one week prior to the execution to arrange the date and time. They were also reminded a day in advance. *Safe environment:* The participants were familiar with the environment as it was done at the schools. This made the participant more at ease. The researcher provided the equipment used during the execution phase (e.g., equilibrium board, chair and the pencil with a rubber puppet on top). The equipment was clean and safe to use.
	Respect the participant's language of choice and ensure understanding of instructions.	The researcher made provision that instructions were provided in the participant's language of choice through the use of a translator.
	Non-maleficence, preventing harm.	A room with a carpet was used to provide a soft surface if the participant lost their balance on the equilibrium board and/or while standing on one leg. The carpet was also used when the participant needed to lie down or stand in half kneel position. In cases where the school did not have a carpeted room available, the researcher provided a therapy mat.
	Privacy and confidentiality. Protecting participant's identity.	Both the schools' and participants' identities were protected by removing all personal information from the documents. Each participant was allocated a number, and the number was recorded on the COs form. The names of the schools were not disclosed and only marked on the COs as to whether the school is classified as a low or middle-high SE school, for data analysis purposes.

(Table 3.5: Ethical principles applied to the study – continued)

Stage of Research	Ethical principle	Strategy to adhere to principle
Execution phase (continued)	Privacy and confidentiality with regard to the video recordings.	All stakeholders involved in the study were aware that video recordings were made and the purpose thereof was described in the permission forms. Safety measurements taken to protect the video recordings were also clearly stipulated (cf. 3.2.4.2 e).
	Feedback to parents/guardians.	Parents/guardians were provided with a short feedback letter, indicating their child's performance on the ten subtests (cf. Appendix J).
	Identifying participants at risk and making referrals.	If the researcher was concerned with a participants' development (physical, cognitive, etc.) during the assessment, additional comments were written on the feedback letter for the parents/guardians, making suggestions for further evaluation and/or referral(s). On the information documents, the parents/guardians were made aware that no treatment would be provided by the researcher.
Post-execution phase	Privacy and confidentiality with regard to the obtained data.	The researcher used a coding system. Each participant and school was provided with a number, and these numbers were used during the data analysis. Thus, the data did not contain any individually identifiable information.
	"Benefit-risk ratio."	The study has benefits for the profession as it (1) contributes to evidence-based practice and (2) allows for more detailed observations through the use of the COs with five-year-old children, enhancing in-depth observations.

(Table 3.5: Ethical principles applied to the study – continued)

Stage of Research	Ethical principle	Strategy to adhere to principle
Writing of dissertation	Avoid plagiarism (University of the Free State, 2010).	Sources used for the dissertation were acknowledged using the 'American Psychological Association' (APA) referencing style as automated by *MS Word* program. To further avoid plagiarism, page numbers were also included, and quotation marks were used when authors were quoted directly or when paraphrased.
	Portray true and accurate data.	The researcher reported accurate data and did not falsify any information.
	Storing and safety of data.	Data will be stored at the UFS and discarded five years post-publication.

3.4 Conclusion

In Chapter 3, the research methodology was discussed. A descriptive observational and cross-sectional study design was used to assess 120 participants, ranging from five years six months to five years eleven months, with the use of an adapted COs. The sampling method used to select schools and participants was thoroughly described, and the data collection process was presented. Strategies employed by the researcher to minimise methodological errors and adherence to ethical principles were also discussed. In Chapter 4 the results of the study will be presented.

CHAPTER 4
Results

4.1 Introduction

The research methodology, described in Chapter 3, enabled the collection of data for this study in a rigorous manner. The results obtained through the collection of data are presented in this chapter. The results will be depicted by means of tables and presentation of results will follow the editorial sequence provided below:

- Demographic information of participants,
- Results of the 10 selected Clinical Observations (COs) items with reference to:
  - <u>Measurable Characteristics</u>
    - Describing the combined measurable characteristics of the subtest with regard to the grade score,
    - Comparing the performance of low socio-economic status (LSES) with high socio-economic status (HSES) on the measurable characteristics, using *p*-values.
  - <u>Observable Characteristics</u>
    - Describing the combined observable characteristics of the subtest with regard to the 'should have' (SH) and 'should not have' (SNH) parameters,
    - Comparing the performance of socio-economic (SE) groups on the observable characteristics' SH and SNH parameters, with the use of *p*-values.

Each subtest's grade scale ranged from grade 1 to 5 and each item had its own grade score specifications (cf. Appendix I). Appendix I also provides a discussion on the procedure for each test which is also depicted by means of a picture for your perusal. Concept clarification for each CO item's observable characteristics referring to the SH and SNH parameters can be found in Appendix L.

Several COs items contain quantitative data (such as duration in seconds or number of repetitions of a movement), described under the heading measurable characteristics.

Quantitative data is displayed according to the range which includes the first (Q_1) and third (Q_3) quartiles, the minimum and maximum values as well as the medians.

With regard to the quartiles, Q_1 refers to the median of the "lower half" of the numerical data with Q_3 referring to the median of the "upper half" of the numerical data.

P-values were rounded off to two decimals. *P*-values less than 0.05 and/or values lower than 0.05, but rounded up to 0.05, were marked with an asterisk (*) to indicate a statistical significant difference.

4.2 Demographic information of participants

The process of selecting the schools and participants included in this study was described in detail in Chapter 3 (cf. 3.2.3). In summary, 120 typically developing participants aged five years six months to five years eleven months from diverse socio-economic statuses (SES), enrolled in 8 pre-schools located in Bloemfontein, Mangaung Metro District, were included in the study.

Of the 250 permission letters distributed after random selection as described in 3.2.3, 127 permission letters were received back. Seven of these participants were not eligible for inclusion in the study due to non-compliance with the inclusion criteria (for example, existence of a diagnosed medical condition, or absence on the day of testing), leading to a final study sample of 120 learners. No participants withdrew during the course of the study. Thirteen participants (10.83%) were referred for further assessment as a result of concerns noted with their performance during the course of the study.

Table 4.1 summarises the demographic information of the participants according to gender, age, language, race and SES.

Table 4.1: Summary of participants' demographic information (compiled by the researcher).

Demographic information	Number of participants *(n)*	Percentage *(%)*
TOTAL PARTICIPANTS:	**120**	
Gender:		
Boys	60	50.00
Girls	60	50.00
Age:		
5 years 6 months	16	13.33
5 years 7 months	30	25.00
5 years 8 months	18	15.00
5 years 9 months	17	14.16
5 years 10 months	27	22.50
5 years 11 months	12	10.00
Home Language:		
Afrikaans	20	16.67
English	14	11.67
Sesotho	86	71.66
Race:		
White	12	10.00
Black	98	81.67
Coloured	10	8.33
SES:		
High	60	50.00
Low	60	50.00

4.3 Results of COs items

The ten selected COs items will now be discussed according to the measurable and observable characteristics.

4.3.1 Diadokokinesis (DDK)

4.3.1.1 Measurable characteristics of DDK test

Table 4.2 illustrates the results of the measurable characteristics present in the group as a whole, as well as for both SE groups separately, while performing the DDK test. The measurable characteristics included a grade score allocation and the number of completed pronation-supination movements in 10 seconds for the right, left and both hands.

Table 4.2: Results of measurable characteristics of DDK test

		Grade 1		Grade 2		Grade 3		Grade 4		Grade 5		Pro-sup	Pro-Sup Range		Pro-sup	Grade difference	Pro-sup difference
		(n)	*(%)*	*(n)*	*(%)*	*(n)*	*(%)*	*(n)*	*(%)*	*(n)*	*(%)*	*(Q_1-Q_3)*			*(Median)*	*(p)*	*(p)*
Right hand	Combined	1	0.83	5	4.17	17	14.17	54	45.00	43	35.83	11-13	1	16	12		
	HSES	0	0.00	4	6.67	14	23.33	27	45.00	15	25.00	10-13	3	15	12	0.00*	0.05
	LSES	1	1.67	1	1.67	3	5.00	27	45.00	28	46.67	11-14	1	16	13		
Left hand	Combined	1	0.83	4	3.33	29	24.17	51	42.50	35	29.17	10-13	2	14	12		
	HSES	0	0.00	2	3.33	18	30.00	29	48.33	11	18.33	10-13	2	14	11	0.05*	0.94
	LSES	1	1.67	2	3.33	11	18.33	22	36.67	24	40.00	9.50-13	2	14	12		
Both hands	Combined	2	1.67	3	2.50	21	17.50	50	41.67	44	36.67	10-13	1	15	12		
	HSES	1	1.67	2	3.33	11	18.33	28	46.67	18	30.00	10-13	1	14	11	0.63	0.18
	LSES	1	1.67	1	1.67	10	16.67	22	36.67	26	43.33	10-13.50	1	15	12		

Pro-sup: Pronation-supination
Q: Quartiles
*$p<0.05$

i) Describing the combined measurable characteristics of the DDK test

Combined scores are shaded in light grey in Table 4.2

The majority of the participants obtained a grade score of 4 while executing the DDK test with the right, left and both hands (41.67% to 45.00%, n=50-54). A grade score of 5 was the second highest grade obtained for the right (35.83%, n=43), left (29.17%, n=35) and both hands (36.67%, n=44) respectively.

The median number of pronation-supination movements performed in 10 seconds was 12, with a Q_1-Q_3 range of 10-13 movements in 10 seconds being the most prevalent across all measurements.

ii) Comparing the performance of SE groups on the measurable characteristics of the DDK test

A significant difference was seen between the SE groups in attaining a grade score of the right (p=0.00) and left hand (p=0.05). The majority of the HSES group performing the DDK with the *right hand*, obtained a grade score of 4 (45.00%, n=27) and 5 (25.00%, n=15) with similar findings in the LSES group as they also obtained a grade score of 4 (45.00%, n=27), but a grade score of 5 was more prevalent in the LSES group (46.67%, n=28).

For the *left hand*, the HSES group obtained a grade score of 4 (48.33%, n=29) and 3 (30.00%, n=18) in the majority of cases, while the LSES obtained a grade score of 4 (36.67%, n=22) and 5 (40.00%, n=24) the most.

No significant difference between the SE groups was seen in the allocation of the grade score for *both hands* as well as the means for number of full *pronation-supination* movements.

4.3.1.2 Observable characteristics of DDK test

Table 4.3 illustrates the observable characteristics present in the group as a whole, as well as for both SE groups separately, while performing the DDK test. The content of the table is arranged from highest to lowest prevalence for SH and SNH parameters respectively.

Table 4.3: Results of observable characteristics of DDK test

			Right Hand			Left Hand			Both Hands		
			(n)	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*
SH Parameters	Thumb next to index finger	Combined	116	96.67		115	95.83		111	92.50	
		HSES	59	98.33	0.62	58	96.67	1.00	56	93.33	1.00
		LSES	57	95.00		57	95.00		55	91.67	
	Rhythmical movement	Combined	105	87.50		98	81.67		102	85.00	
		HSES	52	86.67	0.78	51	85.00	0.35	51	85.00	1.00
		LSES	53	88.33		47	78.33		51	85.00	
	Starting position supinated	Combined	89	74.17		94	78.33		94	78.33	
		HSES	48	80.00	0.14	47	78.33	1.00	47	78.33	1.00
		LSES	41	68.33		47	78.33		47	78.33	
	Isolated forearm movements	Combined	80	66.67		71	59.17		79	65.83	
		HSES	37	61.67	0.25	32	53.33	0.19	38	63.33	0.56
		LSES	43	71.67		39	65.00		41	68.33	
	Starting position pronated	Combined	31	25.83		26	21.67		26	21.67	
		HSES	12	20.00	0.14	13	21.67	1.00	13	21.67	1.00
		LSES	19	31.67		13	21.67		13	21.67	
SNH Parameters	Use vision	Combined	42	35.00		47	39.17		41	34.17	
		HSES	26	43.33	0.06	29	48.33	0.04*	26	43.33	0.03*
		LSES	16	26.67		18	30.00		15	25.00	
	Fixation of upper arm	Combined	40	33.33		54	45.00		45	37.50	
		HSES	22	36.67	0.44	30	50.00	0.27	22	36.67	0.85
		LSES	18	30.00		24	40.00		23	38.33	
	Shoulder elevation	Combined	29	24.17		38	31.67		42	35.00	
		HSES	19	31.67	0.06	24	40.00	0.05*	24	40.00	0.25
		LSES	10	16.67		14	23.33		18	30.00	
	Double tap	Combined	27	22.50		31	25.83		27	22.50	
		HSES	17	28.33	0.13	14	23.33	0.53	12	20.00	0.51
		LSES	10	16.67		17	28.33		15	25.00	
	Press elbows against body	Combined	29	24.17		32	26.67		29	24.17	
		HSES	15	25.00	0.83	17	28.33	0.68	12	20.00	0.29
		LSES	14	23.33		15	25.00		17	28.33	
	Slaps hard on legs	Combined	20	16.67		15	12.50		16	13.33	
		HSES	10	16.67	1.00	9	15.00	0.41	9	15.00	0.59
		LSES	10	16.67		6	10.00		7	11.67	

*$p<0.05$

(Table 4.3: Results of observable characteristics of DDK test – continued)

			Right Hand			Left Hand			Both Hands		
			(n)	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*
SNH Parameters	Hands not flat (c-curved)	Combined	15	12.50		16	13.33		18	15.00	
		HSES	9	15.00	0.41	8	13.33	1.00	9	15.00	1.00
		LSES	6	10.00		8	13.33		9	15.00	
	Rolling forearm on legs	Combined	18	15.00		15	12.50		8	6.67	
		HSES	8	13.33	0.61	9	15.00	0.41	4	6.67	1.00
		LSES	10	16.67		6	10.00		4	6.67	
	Absence of supination	Combined	8	6.67		16	13.33		15	12.50	
		HSES	3	5.00	0.72	7	11.67	0.59	7	11.67	0.78
		LSES	5	8.33		9	15.00		8	13.33	
	Rigid body	Combined	7	5.83		15	12.50		16	13.33	
		HSES	6	10.00	0.11	6	10.00	0.41	6	10.00	0.28
		LSES	1	1.67		9	15.00		10	16.67	
	Associated reactions with mouth	Combined	5	4.17		12	10.00		9	7.50	
		HSES	4	6.67	0.36	8	13.33	0.22	8	13.33	0.03*
		LSES	1	1.67		4	6.67		1	1.67	
	Incoordination	Combined	8	6.67		8	6.67		4	3.33	
		HSES	6	10.00	0.27	4	6.67	1.00	2	3.33	1.00
		LSES	2	3.33		4	6.67		2	3.33	
	Sloppy movement	Combined	4	3.33		3	2.50		5	4.17	
		HSES	4	6.67	0.12	2	3.33	1.00	4	6.67	0.36
		LSES	0	0.00		1	1.67		1	1.67	
	Extreme caution in movement	Combined	4	3.33		2	1.67		1	0.83	
		HSES	2	3.33	1.00	1	1.67	1.00	0	0.00	1.00
		LSES	2	3.33		1	1.67		1	1.67	
	Associated reactions with opposite hand	Combined	0	0.00		9	7.50		0	0.00	
		HSES	0	0.00	-	4	6.67	1.00	0	0.00	-
		LSES	0	0.00		5	8.33		0	0.00	
	Unusual finger movement	Combined	0	0.00		0	0.00		0	0.00	
		HSES	0	0.00	-	0	0.00	-	0	0.00	-
		LSES	0	0.00		0	0.00		0	0.00	

**p*<0.05

i) Describing the combined observable characteristics of the DDK test

Combined scores are shaded in light grey in Table 4.3.

SH Parameters:

The *positioning of the thumb next to the index finger,* during the duration of the DDK test, was observed in the majority of participants (right hand 96.67%, n=116; left hand 95.83%, n=115 and both hands 92.50%, n=111). *Rhythmical movement* was observed among 87.50% (n=105) of participants when performing DDK with the right hand, 81.67% (n=98) when performing with the left hand and 85.00% (n=102) when performing with both hands. The *starting position* preferred by the participants was supinated, respectively observed when performed with the right (74.17%, n=89), left and both hands (78.33%, n=94). *Isolated forearm movements* were observed among 66.67% (n=80) of participants when performing with the right hand, 59.17% (n=71) when performing with the left hand and 65.83% (n=79) when performing with both hands.

SNH Parameters:

Thirty-five percent (n=42) of the participants used *vision* when performing the DDK with the right hand, 39.17% (n=47) when performing the test with the left hand and 34.17% (n=41) used vision when performing with both hands. Thirty-three point three-three percent (33.33%) (n=40) of participants *fixated their body* during the DDK test when performing it with the right hand, 45.00% (n=54) when performing it with the left hand and 37.50% (n=45) when performing it with both hands. All other SNH parameters were observed in 35.00% (n=42) or less of participants when analysing the combined results (e.g., *shoulder elevation* when performing DDK with both hand).

ii) Comparing the performance of SE groups on the observable characteristics of the DDK test

SH Parameters:

No significant differences between the SE groups were evident with regard to the SH parameters.

SNH Parameters:

No significant difference between the two SE groups was evident performing the DDK with the *right hand*.

For the *left hand*, significant differences were seen with *use of vision* (*p*=0.04) and *shoulder elevation* (*p*=0.05). More participants from the HSES *relied on vision* (48.33%, n=29) and *elevated their shoulders* (40.00%, n=24), compared to the LSES (use vision 30.00%, n=18 and shoulder elevation 23.33%, n=14).

During the performance of *both hands*, a significant difference was seen in the *use of vision* (p=0.03) and *associated reactions with the mouth* (*p*=0.03). Forty-three point three-three percent (43.33%) (n=26) of the participants from HSES used *vision,* and 13.33% (n=8) had *associated reactions with the mouth*, compared to 25.00% (n=15) of participants from the LSES that relied on vision with 1.67% (n=1) having associated reactions of the mouth.

4.3.2 Thumb-Finger Touching (TFT)

4.3.2.1 Measurable characteristics of TFT test

Table 4.4 illustrates the results of the measurable characteristics present in the group as a whole, as well as for both SE groups separately while performing the TFT test. The measurable characteristics included only a grade score allocation.

Table 4.4: **Results of measurable characteristics of TFT test**

		Grade 1		Grade 2		Grade 3		Grade 4		Grade 5		Grade difference
		(n)	*(%)*	*(n)*	*(%)*	*(n)*	*(%)*	*(n)*	*(%)*	*(n)*	*(%)*	*(p)*
Right hand	Combined	2	1.67	12	10.00	32	26.67	28	23.33	46	38.33	
	HSES	0	0.00	4	6.67	16	26.67	12	20.00	28	46.67	0.19
	LSES	2	3.33	8	13.33	16	26.67	16	26.67	18	30.00	
Left hand	Combined	2	1.67	20	16.67	36	30.00	21	17.50	41	34.17	
	HSES	0	0.00	2	3.33	20	33.33	12	20.00	26	43.33	0.00*
	LSES	2	3.33	18	30.00	16	26.67	9	15.00	15	25.00	
Both hands	Combined	30	25.00	29	24.17	26	21.67	12	10.00	23	19.17	
	HSES	6	10.00	12	20.00	18	30.00	7	11.67	17	28.33	0.00*
	LSES	24	40.00	17	28.33	8	13.33	5	8.33	6	10.00	
No vision	Combined	26	21.86	39	32.77	28	23.53	13	10.92	14	11.66	
	HSES	6	10.00	17	28.33	21	35.00	8	13.33	8	13.33	0.00*
	LSES	20	33.90	22	37.29	7	11.86	5	8.47	5	8.47	

*p<0.05

i) Describing the combined measurable characteristics of the TFT test

Combined scores are shaded in light grey in Table 4.4.

The majority of the participants obtained a grade score of 5 for the right (38.33%, n=46) and left hand (34.17%, n=41) with only 1.67% (n=2) of participants obtaining a grade score of 1 during unilateral performance.

Twenty-five percent (n=30) of the participants were unable to perform the action with *both hands* and received a grade score of 1. Only 19.17% (n=23) of the participants obtained a grade score of 5 during the performance of TFT with both hands.

During TFT with *no vision*, 32.77% (n=39) of the participants obtained a grade score of 2 and 11.66% (n=14) of the participants obtained a grade score of 5.

ii) Comparing the performance of SE groups on the measurable characteristics of the TFT test

Significant differences were found on the performance of the TFT with the *left hand* (*p*=0.00), *both hands* (*p*=0.00) and with *no vision* (*p*=0.00) between the different SE groups.

The majority of the HSES group, obtained a grade score of 5 (43.33%, n=26) and 3 (33.33%, n=20) while performing the TFT with the *left hand*, with a majority grade score of 2 (30.00%, n=18) and 3 (26.67%, n=16) seen in the LSES group.

The HSES group obtained a grade score of 3 (30.00%, n=18) and 5 (28.33%, n=17) most frequently while performing the TFT with *both hands*, while the LSES mostly obtained a grade score of 1 (40.00%, n=24) and 2 (28.33%, n=17).

With *vision occluded*, a grade score of 3 (35.00%, n=21) and 2 (28.33%, n=17) were most seen in participants from the HSES group, with a grade score of 1 (33.90%, n=20) and 2 (37.29%, n=22) being the majority grade score for participants from the LSES group.

4.3.2.2 Observable characteristics of TFT test

Table 4.5 illustrates the observable characteristics present in the group as a whole, as well as for both SE groups separately while performing the TFT test. The content of the table is arranged from high to low prevalence for both SH and SNH parameters.

Table 4.5: **Results of observable characteristics of TFT test**

			Right Hand			Left Hand			Both Hands			Vision occluded		
			(n)	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*
SH Parameters	Thumb opposition	Combined	119	99.17		120	100.00		119	99.17		116	96.67	
		HSES	60	100.00	1.00	60	100.00	-	60	100	1.00	60	100.00	0.12
		LSES	59	98.33		60	100.00		59	98.33		56	93.33	
	Touch with tip of thumb	Combined	115	95.83		115	95.83		117	97.50		110	91.67	
		HSES	57	95.00	1.00	58	96.67	1.00	59	98.33	1.00	58	96.67	0.05*
		LSES	58	96.67		57	95.00		58	96.67		52	86.67	
	Isolated finger movement	Combined	105	87.50		103	85.83		90	75.00		82	68.33	
		HSES	56	93.33	0.05	55	91.67	0.1	53	88.33	0.00*	46	76.67	0.05*
		LSES	49	81.67		48	80.00		37	61.67		36	60.00	
	Good timing	Combined	70	58.33		57	47.50		32	26.67		25	20.83	
		HSES	36	60.00	0.71	34	56.67	0.04*	21	35.00	0.04*	15	25.00	0.30
		LSES	34	56.67		23	38.33		11	18.33		10	16.67	
	Correct sequence	Combined	57	47.50		54	45.00		29	24.17		16	13.33	
		HSES	35	58.33	0.02*	36	60.00	0.00*	20	33.33	0.02*	9	15.00	0.60
		LSES	22	36.67		18	30.00		9	15.00		7	11.67	
	Double tap on 5th finger	Combined	38	31.67		44	36.67		30	25.00		22	18.33	
		HSES	26	43.33	0.01*	29	48.33	0.01*	21	35.00	0.01*	17	28.33	0.00*
		LSES	12	20.00		15	25.00		9	15.00		5	8.33	

*p<0.05

(Table 4.5: Results of observable characteristics of TFT test – continued)

			Right Hand			Left Hand			Both Hands			Vision occluded		
			(n)	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*
SNH Parameters	Reliance on visual input	Combined	117	97.50		119	99.17		118	98.33		5	4.17	
		HSES	57	95.00	0.24	60	100.00	1.00	60	100.00	0.50	2	3.33	1.00
		LSES	60	100.00		59	98.33		58	96.67		3	5.00	
	Press hard on fingers	Combined	33	27.50		46	38.33		52	43.33		50	41.67	
		HSES	15	25.00	0.54	25	41.67	0.45	27	45.00	0.71	20	33.33	0.06
		LSES	18	30.00		21	35.00		25	41.67		30	50.00	
	Associated reactions with opposite hand	Combined	48	40.00		55	45.83							
		HSES	31	51.67	0.01*	33	55.00	0.04*						
		LSES	17	28.33		22	36.67							
	Don't start with index finger	Combined	25	20.83		29	24.17		30	25.00		32	26.67	
		HSES	12	20.00	0.82	9	15.00	0.02*	12	20.00	0.21	10	16.67	0.01*
		LSES	13	21.67		20	33.33		18	30.00		22	36.67	
	Restart same forward sequence	Combined	28	23.33		22	18.33		24	20.00		22	18.33	
		HSES	9	15.00	0.03*	9	15.00	0.34	13	21.67	0.65	13	21.67	0.35
		LSES	19	31.67		13	21.67		11	18.33		9	15.00	
	Lose sequence	Combined	9	7.50		11	9.17		15	12.50		17	14.17	
		HSES	6	10.00	0.50	8	13.33	0.11	10	16.67	0.17	11	18.33	0.20
		LSES	3	5.00		3	5.00		5	8.33		6	10.00	
	Restart pattern	Combined	13	10.83		14	11.67		10	8.33		9	7.50	
		HSES	9	15.00	0.14	6	10.00	0.60	7	11.67	0.19	3	5.00	0.50
		LSES	4	6.67		8	13.33		3	5.00		6	10.00	
	Associated reactions with mouth	Combined	9	7.50		13	10.83		11	9.17		9	7.50	
		HSES	4	6.67	1.00	7	11.67	1.00	6	10.00	0.80	4	6.67	1.00
		LSES	5	8.33		6	10.00		5	8.33		5	8.33	

**p*<0.05

(Table 4.5: Results of observable characteristics of TFT test – continued)

			Right Hand			Left Hand			Both Hands			Vision occluded		
			(n)	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*
SNH Parameters	Slide along fingers	Combined	6	5.00		9	7.50		9	7.50		11	9.17	
		HSES	2	3.3	0.70	3	5.00	0.50	3	5.00	0.50	3	5.00	0.11
		LSES	4	6.67		6	10.00		6	10.00		8	13.33	
	First perform action with one hand then the other	Combined							33	27.50		19	15.83	
		HSES							9	15.00	0.00*	5	8.33	0.02*
		LSES							24	40.00		14	23.33	
	Correct pattern but performs in reverse (5^{th}-1^{st} finger)	Combined	7	5.83		6	5.00		4	3.33		4	3.33	
		HSES	5	8.33	0.44	4	6.67	0.70	4	6.67	0.12	3	5.00	0.62
		LSES	2	3.33		2	3.33		0	0.00		1	1.67	
	Sloppy movement	Combined	1	0.83		1	0.83		2	1.67		6	5.00	
		HSES	0	0.00	1.00	0	0.00	1.00	1	1.67	1.00	3	5.00	1.00
		LSES	1	1.67		1	1.67		1	1.67		3	5.00	
	Double tap each finger (2-5)	Combined	0	0.00		5	4.17		4	3.33		2	1.67	
		HSES	0	0.00	-	21	3.33	1.00	1	1.67	0.62	0	0.00	0.50
		LSES	0	0.00		3	5.00		3	5.00		2	3.33	
	Slow movement	Combined	5	4.17		1	0.83		1	0.83		2	1.67	
		HSES	2	3.33	1.00	0	0.00	1.00	0	0.00	1.00	0	0.00	0.50
		LSES	3	5.00		1	1.67		1	1.67		2	3.33	

*$p<0.05$

i) Describing the combined observable characteristics of the TFT test

Combined scores are shaded in light grey in Table 4.5.

SH Parameters:

Most participants were able to perform the TFT with good *thumb opposition (*96.67% *to* 100.00%, n=116-120) and were able to *touch their fingers with the tip of the thumb* (91.67% to 97.50%, n=110-117) while performing the TFT with the right, left, and both hands as well as with vision occluded. *Isolated finger movements* were observed during unilateral performance with the right hand, in 87.50% (n=105) of participants and in 85.83% (n=103) of participants with the left hand, while *isolated finger movements* occurred slightly less frequently when performing the action with both hands (75.00%, n=90) and with vision occluded (68.33%, n=82). The lowest SH parameter was *double tapping the fifth finger*. This was observed among 31.67% (n=38) of participants when performed with the right hand, 36.67% (n=44) when performed with the left hand, 25.00% (n=30) when performed with both hands and decreased to 18.33% (n=22) prevalence when vision was occluded.

SNH Parameters:

A high prevalence of *reliance on visual input* was observed in the majority of the participants (right hand 97.50%, n=117; left hand 99.17%, n=119 and both hands 98.83% n=118). Four point one-seven percent (4.17%) (n=5) of the participants were unable to perform the action without using vision. The SNH parameter *pressed hard on fingers* was observed among 27.50% (n=33) of the participants while performed TFT with the right hand, 38.33% (n=46) when performed with the left hand and increased during the performance with both hands (43.33%, n=52) and vision occluded (41.67%, n=50). *Associated reactions with the opposite hand*, during unilateral performance, were observed among 40.00% (n=48) of participants when performed with the right hand and 45.83% (n=55) when performed with the left hand.

All other SNH parameters were observed in 27.50% (n=33) or less of participants when analysing the combined results (e.g. *first perform the action with one hand then the other* while performing the TFT with both hands).

ii) Comparing the performance of SE groups on the observable characteristics of the TFT test

<u>SH Parameters:</u>

One SH parameter was found to have a significant difference between the SE groups, throughout the execution of the TFT, namely *double tapping the fifth finger* (*p*=0.00 to *p*=0.01) as it was observed more frequently in the HSES group (28.33% to 48.33%, n=17-29), compared to the LSES group (8.33% to 25.00%, n=5-15).

Performing the action with the *correct sequence*, also had a significant difference (*p*=0.00 to *p*=0.02) between the groups, during the execution of the action with vision. The parameter was more observed in the HSES group (33.33% to 60.00%, n=20-36), compared to the LSES group (15.00% to 36.67%, n=9-22).

Other SH parameters with a significant difference were *good timing* (*p*=0.04), *isolated finger movement* (*p*=0.00 to *p*=0.05) and *touching tip of thumb* (*p*=0.05). *Good timing* was observed more frequently in the HSES group (35.00% to 56.67%, n=21-34), during execution of the action with the left and both hands, compared to the LSES group (18.33% to 38.33%, n=11-23). *Isolated finger movements* were observed in the HSES group (76.67% to 88.33%, n=46-53), during bilateral execution of the TFT, compared to those from LSES group (60.00% to 61.67%, n=36-37). *Touching tip of thumb* (*p*=0.05) was observed more frequently in the HSES group (96.67%, n=58), during execution of TFT with vision occluded, compared to those from LSES group (86.67%, n=52).

<u>SNH Parameters:</u>

With regard to the *right hand*, SNH parameters with a significant difference in the SE groups, were *associated reactions with opposite hand* (*p*=0.01) and *restarting the same forward sequence* (*p*=0.03). More participants from the HSES group (51.67%, n=31) had *associated reactions with the opposite hand* compared to those from LSES (28.33%, n=17), however, *restarting the same forward sequence* were seen less frequently in participants from HSES (15.00%, n=9) when compared to the participants from the LSES group (31.67%, n=19).

Significant differences were found in the *left hand* with regard to *not starting the sequence with the index finger* (*p*=0.02) and *associated reactions of the opposite hand* (*p*=0.04). More participants from the LSES group (33.33%, n=20) *started with a finger other than the index*, than those of HSES (15.00%, n=9). However, participants from HSES had *more associated reactions of the opposite hand* (55.00%, n=33) than participants from LSES (36.67%, n=22).

With regard to *both hands*, no other SNH parameter had a significant difference other than *performing the task with one hand then the other* (*p*=0.00). This was more frequently observed in participants from LSES (40.00%, n=24) compared to participants from HSES (15.00%, n=9).

SNH parameters with a significant difference for *vision occluded,* were *starting position other than index finger* (*p*=0.01) and *not performing the action with both hands simultaneously* (*p*=0.02). More participants from the LSES group (36.67%, n=22) *started with a finger other than the index*, compared to those participants from the HSES group (16.67%, n=10). *Not performing the action with both hands simultaneously* was more frequently observed in participants from LSES (23.33%, n=14) compared to those from HSES (8.33%, n=5).

4.3.3 Equilibrium Reactions (ER)

4.3.3.1 Measurable characteristics of ER test

Table 4.6 illustrates the results of the measurable characteristics present in the group as a whole, as well as for both SE groups separately, while performing the ER test. The measurable characteristics included a grade score allocation.

Table 4.6: Results of measurable characteristics of ER test

		Grade 1		Grade 2		Grade 3		Grade 4		Grade 5		Grade difference
		(n)	*(%)*	*(n)*	*(%)*	*(n)*	*(%)*	*(n)*	*(%)*	*(n)*	*(%)*	*(p)*
Prone	Combined	0	0.00	0	0.00	20	16.67	19	15.83	81	67.50	
	HSES	0	0.00	0	0.00	8	13.33	5	8.33	47	78.33	0.03*
	LSES	0	0.00	0	0.00	12	20.00	14	23.33	34	56.67	
Four point kneel	Combined	0	0.00	2	1.67	10	8.33	25	20.83	83	69.17	
	HSES	0	0.00	1	1.67	4	6.67	9	15.00	46	76.67	0.30
	LSES	0	0.00	1	1.67	6	10.00	16	26.67	37	61.67	
Upright kneel	Combined	0	0.00	10	8.33	40	33.33	50	41.67	20	16.67	
	HSES	0	0.00	4	6.67	25	41.67	19	31.67	12	20.00	0.09
	LSES	0	0.00	6	10.00	15	25.00	31	51.67	8	13.33	
Long sit	Combined	1	0.83	11	9.17	39	32.50	34	28.33	35	29.17	
	HSES	0	0.00	8	13.33	14	23.33	15	25.00	23	38.33	0.04*
	LSES	1	1.67	3	5.00	25	41.67	19	31.67	12	20.00	

*$p<0.05$

i) Describing the combined measurable characteristics of the ER test

Combined scores are shaded in light grey in Table 4.6.

In *prone* position, the majority of the participants obtained a grade score of 5 (67.50%, n=81) and none of the participants obtained a grade score of 1 and 2 (0.00%, n=0). In *four point kneel* position, 69.17% (n=83) of the participants obtained a grade score of 5 and 0.00% (n=0) of the participants obtained a grade score of 1. In *upright kneel* position, 41.67% (n=50) of the participants obtained a grade score of 4 and none of the participants obtained a grade score of 1 (0.00%, n=0). In *long sit*, the majority of the participants (32.50%, n=39) obtained a grade score of 3, followed by a grade score of 5 (29.17%, n=35).

ii) Comparing the performance of SE groups on the measurable characteristics of the ER test

A significant grade difference in *prone* (*p*=0.03) and *long sit* (*p*=0.04) on the performance of participants from the two SE groups, was evident. More participants from HSES obtained a grade score of 5 in *prone* position (78.33%, n=47), compared to those from LSES (56.67%, n=34). This was also the case *with long sit*, as the majority of participants from HSES obtained a grade score of 5 (38.33%, n=23), with a second highest grade score of 4 (25.00%, n=15), while the majority of participants from LSES obtained a grade score of 3 (41.67%, n=25) and 4 (31.67%, n=19) while in long sit.

Results indicate similar grade score allocations for the two SE groups in *four point kneel* (*p*=0.30) and *upright kneel* (*p*=0.09) positions.

4.3.3.2 Observable characteristics of ER test

Table 4.7 illustrates the observable characteristics present in the group as a whole, as well as for both SE groups separately, while performing the ER test. The content of the table is arranged from high to low prevalence for both SH and SNH parameters.

Table 4.7: Results of observable characteristics of ER test

			Prone			Four point kneel			Upright kneel			Long sit		
			(n)	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*
SH Parameters	Elongation of weight bearing side	Combined	111	92.50		120	100.00		118	98.33		120	100.00	
		HSES	58	96.67	0.16	60	100.00	-	59	98.33	1.00	60	100.00	-
		LSES	53	88.33		60	100.00		59	98.33		60	100.00	
	Flexion of non-weight bearing side	Combined	103	85.83		119	99.17		118	98.33		120	100.00	
		HSES	57	95.00	0.00*	60	100.00	1.00	59	98.33	1.00	60	100.00	-
		LSES	46	76.67		59	98.33		59	98.33		60	100.00	
	Weight shift	Combined	103	85.83		112	93.33		113	94.17		114	95.00	
		HSES	51	85.00	0.80	54	90.00	0.30	55	91.67	0.44	55	91.67	0.21
		LSES	52	86.67		58	96.67		58	96.67		59	98.33	
	Trunk Rotation	Combined	19	15.83		99	82.50		110	91.67		25	20.83	
		HSES	13	21.67	0.08	50	83.33	0.81	55	91.67	1.00	16	26.67	0.12
		LSES	6	10.00		49	81.67		55	91.67		9	15.00	
	Fluid response	Combined	39	32.50		51	42.50		39	32.50		30	25.00	
		HSES	17	28.33	0.33	21	35.00	0.10	18	30.00	0.60	16	26.67	0.70
		LSES	22	36.67		30	50.00		21	35.00		14	23.33	

*$p<0.05$

(Table 4.7: Results of observable characteristics of ER test – continued)

			Prone			Four point kneel			Upright kneel			Long sit		
			(n)	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*
SNH Parameters	Lower centre of mass	Combined				34	28.33		101	84.17		49	40.83	
		HSES				18	30.00	0.70	50	83.33	0.80	26	43.33	0.60
		LSES				16	26.67		51	85.00		23	38.33	
	Widen base of support	Combined	53	44.17		5	4.17		15	12.50		63	52.50	
		HSES	33	55.00	0.02*	2	3.33	1.00	7	11.67	0.80	32	53.33	0.90
		LSES	20	33.33		3	5.00		8	13.33		31	51.67	
	Relies on protective extension	Combined	28	23.33		1	0.83		22	18.33		50	41.67	
		HSES	10	16.67	0.1	1	1.67	1.00	16	26.67	0.02*	23	38.33	0.50
		LSES	18	30.00		0	0.00		6	10.00		27	45.00	
	Rigid response	Combined	13	10.83		19	15.83		24	24.00		20	16.67	
		HSES	3	5.00	0.04*	8	13.33	0.50	11	18.33	0.65	6	10.00	0.05
		LSES	10	16.67		11	18.33		13	21.67		14	23.33	
	Lordosis and anterior tilt of pelvis	Combined	0	0.00		44	36.67		87	72.50		0	0.00	
		HSES	0	0.00	-	21	35.00	0.70	41	68.33	0.31	0	0.00	-
		LSES	0	0.00		23	38.33		46	76.67		0	0.00	
	Arm abduction <45°	Combined	1	0.83					66	55.00		0	0.00	
		HSES	1	1.67	1.00				37	61.67	0.14	0	0.00	-
		LSES	0	0.00					29	48.33		0	0.00	
	Holds onto tilt board	Combined	16	13.33		4	3.33		4	3.33		12	10.00	
		HSES	11	18.33	0.11	1	1.67	0.62	3	5.00	0.62	7	11.67	0.54
		LSES	5	8.33		3	5.00		1	1.67		5	8.33	
	Fixate arms against body	Combined	20	16.67		0	0.00		33	27.50		19	15.83	
		HSES	12	20.00	0.33	0	0.00	-	17	28.33	0.84	6	10.00	0.08
		LSES	8	13.33		0	0.00		16	26.67		13	21.67	

*$p<0.05$

(Table 4.7: Results of observable characteristics of ER test – continued)

			Prone			Four point kneel			Upright kneel			Long sit		
			(n)	***(%)***	***(p)***	***(n)***	***(%)***	***(p)***	***(n)***	***(%)***	***(p)***	***(n)***	***(%)***	***(p)***
SNH Parameters	Associated reactions with mouth	Combined	0	0.00		0	0.00		14	11.67		13	10.83	
		HSES	0	0.00	-	0	0.00	-	6	10.00	0.60	5	8.33	0.40
		LSES	0	0.00		0	0.00		8	13.33		8	13.33	
	C-curve in upper trunk	Combined	0	0.00		5	4.17		2	1.67		84	70.00	
		HSES	0	0.00	-	4	6.67	0.40	1	1.67	1.00	42	70.00	1.00
		LSES	0	0.00		1	1.67		1	1.67		42	70.00	
	Arm abduction >45°	Combined	0	0.00		0	0.00		10	8.33		1	0.83	
		HSES	0	0.00	-	0	0.00	-	5	8.33	1.00	1	1.67	1.00
		LSES	0	0.00		0	0.00		5	8.33		0	0.00	
	Press feet together	Combined	2	1.67		11	9.17		6	5.00		6	5.00	
		HSES	1	1.67	1.00	5	8.33	0.80	4	6.67	0.70	2	3.33	0.70
		LSES	1	1.67		6	10.00		2	3.33		4	6.67	
	Grasp clothes	Combined	0	0.00		0	0.00		5	4.17		3	2.50	
		HSES	0	0.00	-	0	0.00	-	2	3.33	1.00	1	1.67	1.00
		LSES	0	0.00		0	0.00		3	5.00		2	3.33	

*$p<0.05$

i) Describing the combined observable characteristics of the ER test

Combined scores are shaded in light grey in Table 4.7.

SH Parameters:

In prone, 92.50% (n=111) of the participants presented with *elongation of weight bearing side*, 85.83% (n=103) presented with *flexion of non-weight bearing side* and *weight shift* was observed in 85.83% (n=103) of the participants.

In *four point kneel,* 82.50% (n=99) of the participants presented with *trunk rotation* with 100.00% (n=120) *elongation* and 99.17% (n=119) *flexion of non-weight bearing side*. *Weight shift* was observed in 93.33% (n=112) of the participants with the highest *fluid response* prevalence of 42.50% (n=51).

In *upright kneel, trunk rotation* was observed in 91.67% (n=110) of the participants, with *elongation and flexion of non-weight bearing side* observed in 98.33% (n=118) of the participants. *Weight shift* was observed in 94.17% (n=113) of the participants, with 32.50% (n=39) executing the *action fluidly*.

In *long sit,* the prominent indicators observed were *elongation and flexion of non-weight bearing side*, both with a prevalence of 100.00% (n=120). Ninety-five percent (95.00%) (n=114) of the participants *shifted their weight*, with low prevalence of *trunk rotation* (20.83%, n=25) and the *lowest fluid response* of 25.00% (n=30).

SNH Parameters:

In *prone,* six out of the 13 SNH indicators were not observed in the participants. Forty-four point one seven percent (44.17%) (n=53) of participants *widen their base of support*, 23.33% (n=28) *relied on protective extension* with 16.67% (n=20) *fixating their arms* against their bodies.

In *four point kneel,* 36.67% (n=44) of the participants had *lordosis and an anterior pelvic tilt*, 28.33% (n=34) of the participants *lowered their centre of mass* with 15.83% (n=19) presented with a *rigid response*.

All other SNH parameters were observed in 9.17% (n=11) or less of participants when analysing the combined results (e.g. *pressing feet together)*.

In *upright kneel,* the majority of participants *lowered their centre of mass* as it was observed in 84.17% (n=101) of the participants. Seventy-two and a half (72.50%) (n=87) percent of the participants presented with *lordosis and an anterior pelvic tilt* and *arm abduction less than 45°* was present in 55.00% (n=66) of participants. All other SNH parameters were observed in 27.50% (n=33) or less of participants when analysing the combined results (e.g. *fixated their arms against their bodies*).

In *long sit,* 70.00% (n=84) of the participants presented with a *c-curve in the upper trunk*. Fifty-two and a half percent (52.50%) (n=63) of the participants *widen their base of support* while *lowering the centre of mass showed* a prevalence of 40.83% (n=49). Forty-one point six-seven percent (41.67%) (n=50) of the participants *relied on protective extension*. All other SNH parameters were observed in 16.67% (n=20) (e.g. *rigid response*) or less of participants when the combined results were analysed.

ii) Comparing the performance of SE groups on the observable characteristics of the ER test

<u>SH Parameters:</u>

In *prone, flexion of non-weight bearing side* between the two SE groups, indicated a significant difference (*p*=0.00) was seen in the prevalence, as it was more prevalent in participants from HSES (95.00%, n=57) compared to LSES group (76.67%, n=46). Results of the remaining SH parameter in *four point kneel, upright kneel* and *long sit*, similar performances on the two SE groups were seen.

<u>SNH Parameter:</u>

In *prone*, the SNH parameters with a significant difference in the performance of the two SE groups, were *rigid response* (*p*=0.04) and *widen base of support* (*p*=0.02). Participants from LSES (16.67%, n=10) more frequently displayed a *rigid response* compared to those from HSES (5.00%, n=3).

However, participants from HSES (55.00%, n=33), displayed a higher prevalence of *widen their base of support* compared to LSES (33.33%, n=20). The rest of the results indicated similar performance in prone position between the two SE groups.

In *upright kneel* position, only one SNH parameter, *relies on protective extension*, indicated a significant difference (*p*=0.02), as it was more prevalent in participants from HSES (26.67%, n=16), compared to LSES (10.00%, n=6).

No difference in the performance of the two SE groups in *four point kneel* and *long sit* position were evident.

4.3.4 Prone Extension Posture (PEP)

4.3.4.1 Measurable Characteristics of PEP test

Table 4.8 illustrates the results of the measurable characteristics present in the group as a whole, as well as for both SE groups separately, while performing the PEP test. The measurable characteristics included a grade score allocation and the duration in seconds to maintain the PEP.

Table 4.8: Results of measurable characteristics of PEP test

		Performaction	**Grade 1**		**Grade 2**		**Grade 3**		**Grade 4**		**Grade 5**		**Duration (Q_1-Q_3)**	**Duration Range**		**Duration Median**	**Grade difference**	**Duration difference**
		(n)	***(n)***	***(%)***	***(n)***	***(%)***	***(n)***	***(%)***	***(n)***	***(%)***	***(n)***	***(%)***	***(sec)***	***(sec)***	***sec)***	***(sec)***	***(p)***	***(p)***
Full PEP	Combined	64	0	0.00	5	4.17	10	8.33	3	2.50	46	38.33	13.00-24.00	6.00	61.00	18.00		
	HSES	33	0	0.00	1	3.03	5	15.15	1	3.03	26	78.79	14.00-26.00	8.00	61.00	18.00	0.45	0.30
	LSES	31	0	0.00	4	12.90	5	16.13	2	6.45	20	64.52	12.00-23.00	6.00	50.00	18.00		
Bent legs	Combined	13	0	0.00	1	0.83	3	2.50	2	1.67	7	5.83	13.00-19.00	7.00	30.00	15.00		
	HSES	9	0	0.00	1	11.11	1	11.11	2	22.22	5	55.56	13.00-20.00	7.00	30.00	15.00	0.58	0.64
	LSES	4	0	0.00	0	0.00	2	50.00	0	0.00	2	50.00	12.50-17.50	12.00	19.00	14.50		
Arms only	Combined	43	0	0.00	3	2.50	6	5.00	9	7.50	25	20.83	16.00-45.00	7.00	100.00	27.00		
	HSES	18	0	0.00	1	5.56	4	22.22	4	22.22	9	50.00	16.00-39.00	7.00	63.00	23.50	0.60	0.56
	LSES	25	0	0.00	2	8.00	2	8.00	5	20.00	16	64.00	16.00-45.00	8.00	100.00	28.00		

Q: Quartiles
*$p<0.05$

i) Describing the combined measurable characteristics of the PEP test

Combined scores are shaded in light grey in Table 4.8.

The participants were scored according to their ability to either perform the full PEP, PEP with bent legs or PEP arms only (cf. Appendix I). The rationale for first identifying which position the participant can assume, was to identify what the most common PEP position is for a typically developing five-year-old child.

With *full PEP,* 64 (53.33%) participants were able to perform the action, extending and lifting both arms and legs. Overall, 38.33% (n=46) of the participants obtained a grade score of 5, with 2.50% (n=3) obtaining a grade score of 4 for the full PEP. The median seconds to maintain the full PEP were *18.00* seconds, with a Q_1-Q_3 range of 13.00-24.00 seconds.

With *PEP bent legs*, 13 (10.83%) participants needed to bend their knees 90° to maintain the posture. Overall, 5.83% (n=7) of the participants obtained a grade score of 5, and 0.83% (n=1) obtained a grade score of 2. The median seconds to maintain the PEP with bent legs were *15.00* seconds, with a Q_1-Q_3 range of 13.00-19.00 seconds.

With *PEP arms only*, 43 (35.83%) participants were unable to extend both arms and legs and only lifted the arms and head. Overall, 20.83% (n=25) of the participants obtained a grade score of 5 and 2.50% (n=3) obtained a grade score of 2. The median seconds to maintain the PEP arms only were *27.00* seconds, with a Q_1-Q_3 range of 16.00-45.00 seconds.

ii) Comparing the performance of SE groups on the measurable characteristics of the PEP test

No significant differences were evident with regard to the grade score and duration in seconds for the two SE groups.

4.3.4.2 Observable Characteristics of PEP test

Table 4.9 illustrates the observable characteristics present in the group as a whole, as well as for both SE groups separately, while performing the PEP test. The content of the table is arranged from high to low prevalence for both SH and SNH parameters.

Table 4.9: Results of observable characteristics of PEP test

		SES	*(n)*	*(%)*	*(p)*
SH Parameters	Elbows with or behind shoulders	Combined	104	86.66	
		HSES	52	86.67	0.61
		LSES	52	86.67	
	Head held steady	Combined	95	79.17	
		HSES	47	78.33	0.82
		LSES	48	80.00	
	Arch in upper trunk	Combined	92	76.67	
		HSES	45	75.00	0.70
		LSES	47	78.33	
	Head vertical ≥ 45°	Combined	84	70.00	
		HSES	41	68.33	0.70
		LSES	43	71.67	
	Knees bent (less than 45°)	Combined	47	39.16	
		HSES	28	46.67	0.06
		LSES	19	31.67	
	Thighs off mat, from mid-thigh distally	Combined	39	32.50	
		HSES	24	40.00	0.08
		LSES	15	25.00	
	Lifts limbs simultaneously	Combined	38	31.67	
		HSES	24	40.00	0.05*
		LSES	14	23.33	
SNH Parameters	Elevation of shoulder	Combined	82	68.33	
		HSES	34	56.67	0.01*
		LSES	48	80.00	
	Fixation of body	Combined	60	50.00	
		HSES	29	48.33	0.72
		LSES	31	51.67	
	Unable to lift knees off the ground	Combined	43	35.83	
		HSES	18	30.00	0.25
		LSES	25	41.67	
	Thighs barely off mat	Combined	38	31.67	
		HSES	18	30.00	0.70
		LSES	20	33.33	

*$p<0.05$

(Table 4.9: Results of observable characteristics of PEP test – continued)

		SES	***(n)***	***(%)***	***(p)***
SNH Parameters	Head raised less than 45°	Combined	36	30.00	
		HSES	19	31.67	0.70
		LSES	17	28.33	
	Flexed knees (50°- before 90°)	Combined	30	25.00	
		HSES	14	23.33	0.83
		LSES	16	26.67	
	Back appears flat or minimally arched	Combined	28	23.33	
		HSES	14	23.33	1.00
		LSES	14	23.33	
	Rocking body	Combined	27	22.50	
		HSES	14	23.33	0.83
		LSES	13	21.67	
	Excessive effort required to maintain posture	Combined	24	20.00	
		HSES	12	20.00	1.00
		LSES	12	20.00	
	Unable to count aloud	Combined	23	19.17	
		HSES	6	10.00	0.01*
		LSES	17	28.33	
	Assumes posture segmented	Combined	UL 30 / LL 9	UL 25.00 / LL 7.50	
		HSES	UL 13 / LL 5	UL 21.67 / LL 8.33	0.76
		LSES	UL 17 / LL 4	UL 28.33 / LL 6.67	
	Elbows forward of shoulders	Combined	16	13.33	
		HSES	7	11.67	0.60
		LSES	9	15.00	
	Stabilise legs placing one foot over another	Combined	14	11.67	
		HSES	8	13.33	0.60
		LSES	6	10.00	
	Associated reactions with mouth	Combined	6	5.00	
		HSES	3	5.00	1.00
		LSES	3	5.00	
	Asymmetry between sides	Combined	4	3.33	
		HSES	3	5.00	0.62
		LSES	1	1.67	

UL: Upper Limbs ; LL: Lower Limbs
*p<0.05

i) Describing the combined observable characteristics of the PEP test

Combined scores are shaded in light grey in Table 4.9

<u>SH Parameters:</u>

Eighty-six point six-six percent (86.66%) (n=104) of the participants' *elbows were with or behind the shoulders* with a *steady head* observed in 79.17% (n=95) of the participants. Seventy-six point six seven percent (76.67%) (n=92) of the participants had an *arch in the upper trunk* and 70.00% (n=84) *lifted their head more than 45°*. All other SN parameters were observed in 39.16% (n=47) (e.g. *knee flexion less than 45°*) or less of participants when analysing the combined results.

<u>SNH Parameters:</u>

Two SNH parameters were more prevalent: *shoulder elevation* and *fixation of body*. Sixty-eight point three-three percent (68.33%) (n=82) of the participants had *shoulder elevation* with 50.00% (n=60) *fixating their body*. All other SNH parameters were observed in 35.83% (n=43) or less of participants when analysing the combined results [(e.g. *unable to lift their knees off the ground*)].

ii) Comparing the performance of SE groups on the observable characteristics of the PEP test

<u>SH Parameters:</u>

There was a significant difference between the two SE groups on the parameter *lifting limbs simultaneously* (p=0.05). More participants from HSES (40.00%, n=24) lifted their limbs simultaneously compared to LSES (23.33%, n=14).

<u>SNH Parameters:</u>

For the SNH parameters, a significant difference was evident with regard to two parameters; *elevation of shoulders* and *counting aloud*. *Shoulder elevation* was more prevalent in participants from LSES (80.00%, n=48), compared to HSES (56.67%, n=34). *Unable to count aloud* had similar findings, as more participants from LSES (28.33%, n=17) were unable to count aloud, compared to participants from HSES (10.00%, n=6).

4.3.5 Tonic Neck Reflexes: Asymmetrical Tonic Neck Reflex (ATNR), Reflex Inhibiting Posture (RIP) & Symmetrical Tonic Neck Reflex (STNR)

4.3.5.1. ATNR

4.3.5.1.1 Measurable characteristics of ATNR test

Table 4.10 illustrates the results of the measurable characteristics present in the group as a whole, as well as for both SE groups separately, while performing the ATNR test. The measurable characteristics included a grade score allocation and the degree of elbow flexion when the head is turned to either sides.

Table 4.10: Results of measurable characteristics of ATNR test

	Grade 1		Grade 2		Grade 3		Grade 4		Grade 5		Degree R (Q_1-Q_3)	Degree L (Q_1-Q_3)	Degree Range R		Degree Range L		Degree Median R	Degree Median L	Grade difference	Difference in degree
	(n)	*(%)*	*(n)*	*(%)*	*(n)*	*(p)*	*(n)*	*(%)*	*(n)*	*(%)*	*(°)*	*(°)*	*(°)*	*(°)*	*(°)*	*(°)*	*(°)*	*(°)*	*(p)*	*(p)*
Combined	106	88.33	6	5.00	3	2.50	1	0.83	4	3.33	54.00-83.00	57.00-82.50	0	98.00	0	119.00	71.50	74.00		
HSES	52	86.67	4	6.67	1	1.67	1	1.67	2	3.33	51.50-84.50	48.50-79.50	0	98.00	0	95.00	74.00	68.50	0.87	0.97
LSES	54	90.00	2	3.33	2	3.33	0	0.00	2	3.33	60.00-82.00	64.00-85.00	0	95.00	10	119.00	71.00	75.00		

R: Right; L: Left
Q: Quartiles
*p<0.05

i) Describing the combined measurable characteristics of the ATNR test

Combined scores are shaded in light grey in Table 4.10.

A grade score of 1 was obtained by 88.33% (n=106) of the participants with only 3.33% (n=4) of the participants obtaining a grade score of 5.

The median degree of elbow flexion for the *right* side was *71.50°,* with a Q_1-Q_3 range of 54.00° - 83.00°. The median degree of elbow flexion for the *left* side was *74.00°,* with a Q_1-Q_3 range of 57.00° - 82.50°.

ii) Comparing the performance of SE groups on the measurable characteristics of the ATNR test

No significant difference between the SE groups was evident with regard to the grade scores (p=0.87) and the degree of elbow flexion (p=0.97).

4.3.5.1.2 Observable characteristics of ATNR test

Table 4.11 illustrates the observable characteristics present in the group as a whole, as well as for both SE groups separately, while performing the ATNR test. The content of the table is arranged from high to low prevalence for both SH and SNH parameters.

Table 4.11: Results of observable characteristics of ATNR test

<table>
<tr><th colspan="3"></th><th colspan="3">Head turn right</th><th colspan="3">Head turn left</th></tr>
<tr><th colspan="3"></th><th>(n)</th><th>(%)</th><th>(p)</th><th>(n)</th><th>(%)</th><th>(p)</th></tr>
<tr><td rowspan="6">SH Parameters</td><td rowspan="3">Elbow flexion present but less than 25°</td><td>Combined</td><td>8</td><td>6.67</td><td></td><td>6</td><td>5.00</td><td></td></tr>
<tr><td>HSES</td><td>5</td><td>8.33</td><td rowspan="2">0.72</td><td>3</td><td>5.00</td><td rowspan="2">1.00</td></tr>
<tr><td>LSES</td><td>3</td><td>5.00</td><td>3</td><td>5.00</td></tr>
<tr><td rowspan="3">No changes in joint position of arms</td><td>Combined</td><td>0</td><td>0.00</td><td></td><td>0</td><td>0.00</td><td></td></tr>
<tr><td>HSES</td><td>0</td><td>0.00</td><td rowspan="2">-</td><td>0</td><td>0.00</td><td rowspan="2">-</td></tr>
<tr><td>LSES</td><td>0</td><td>0.00</td><td>0</td><td>0.00</td></tr>
<tr><td rowspan="9">SNH Parameters</td><td rowspan="3">Elbow flexion of contralateral arm</td><td>Combined</td><td>110</td><td>91.67</td><td></td><td>111</td><td>92.50</td><td></td></tr>
<tr><td>HSES</td><td>54</td><td>90.00</td><td rowspan="2">0.51</td><td>56</td><td>93.33</td><td rowspan="2">1.00</td></tr>
<tr><td>LSES</td><td>56</td><td>93.33</td><td>55</td><td>91.67</td></tr>
<tr><td rowspan="3">Tends to lock elbows</td><td>Combined</td><td>77</td><td>64.17</td><td></td><td>76</td><td>63.33</td><td></td></tr>
<tr><td>HSES</td><td>42</td><td>70.00</td><td rowspan="2">0.18</td><td>41</td><td>68.33</td><td rowspan="2">0.26</td></tr>
<tr><td>LSES</td><td>35</td><td>58.33</td><td>35</td><td>58.33</td></tr>
<tr><td rowspan="3">Resistance to head turn</td><td>Combined</td><td>55</td><td>45.83</td><td></td><td>55</td><td>45.83</td><td></td></tr>
<tr><td>HSES</td><td>29</td><td>48.33</td><td rowspan="2">0.58</td><td>29</td><td>48.33</td><td rowspan="2">0.58</td></tr>
<tr><td>LSES</td><td>26</td><td>43.33</td><td>26</td><td>43.33</td></tr>
<tr><td colspan="9">*p<0.05</td></tr>
</table>

i) Describing the combined observable characteristics of the ATNR test

Combined scores are shaded in light grey in Table 4.11.

<u>SH Parameters:</u>

Elbow flexion less than 25°, was present when the head was turned to the right (6.67%, n=8) and left (5.00% n=6), with *changes in joint position* seen in all 120 (100.00%) of the participants when the head was turned to either sides.

<u>SNH Parameters:</u>

Elbow flexion of contralateral arm was observed in 91.67% (n=110) of the participants when the head was turned to the right and observed in 92.50% (n=111) when the head was turned to the left. The difference between the percentage of this parameter and the parameter of elbow flexion described above (cf. SH parameter), indicates participants that presented with no elbow flexion (head turn right 1.66%, n=2 and head turn left 2.50%, n=3).

The prevalence of *head resistance* was similar when the head was turned to both sides and observed in 45.83% (n=55) of the participants.

ii) Comparing the performance of SE groups on the observable characteristics of the ATNR test

No differences were evident on the SH and SNH parameters when comparing the two SE groups on the ATNR test.

4.3.5.2 RIP

4.3.5.2.1 Measurable characteristics of RIP test

Table 4.12 illustrates the results of the measurable characteristics present in the group as a whole, as well as for both SE groups separately, while performing the RIP test. The measurable characteristics included a grade score allocation and the duration in seconds to maintain the RIP position when the head is turned to the right and left.

Table 4.12: Results of measurable characteristics of RIP test

		Grade 1		Grade 2		Grade 3		Grade 4		Grade 5		Duration (Q_1-Q_3)	Duration Range		Duration Median	Grade difference	Duration difference
		(n)	*(%)*	*(n)*	*(%)*	*(n)*	*(p)*	*(n)*	*(%)*	*(n)*	*(%)*	*(sec)*	*(sec)*	*(sec)*	*(sec)*	*(p)*	*(p)*
RIP Right	Combined	8	6.67	20	16.67	16	13.33	14	11.67	62	51.67	4.00-11.00	0.00	45.00	6.00		
	HSES	3	5.00	10	16.67	10	16.67	8	13.33	29	48.33	4.00-11.00	1.00	33.33	6.00	0.77	0.48
	LSES	5	8.33	10	16.67	6	10.00	6	10.00	33	55.00	3.00-10.00	1.00	32.00	6.00		
RIP Left	Combined	9	7.50	19	15.83	10	8.33	19	15.83	63	52.50	4.00-13.00	1.00	36.00	7.00		
	HSES	6	10.00	10	16.67	5	8.33	8	13.33	31	51.67	3.50-13.00	1.00	32.00	6.00	0.82	0.51
	LSES	3	5.00	9	15.00	5	8.33	11	18.33	32	53.33	4.00-12.50	1.00	36.00	7.00		

Q: Quartiles

*p<0.05

i) Describing the combined measurable characteristics of the RIP test

Combined scores are shaded in light grey in Table 4.12.

For the *right side*, 51.67% (n=62) of the participants obtained a grade score of 5. The median seconds to maintain the RIP position to the *right* side was *6.00* seconds, with a Q_1-Q_3 range of 4.00-11.00 seconds.

For the *left side*, 52.50% (n=63) of the participants obtained a grade score of 5. The median seconds to maintain the RIP position to the *left* side was *7.00* seconds, with a Q_1-Q_3 range of 4.00-13.00 seconds.

ii) Comparing the performance of SE groups on the measurable characteristics of the RIP test

No significant difference in the performance of the two SE groups on the RIP test was evident, with regard to the grade score (p=0.77 and p=0.82) and duration (p=0.48 and p=0.51).

4.3.5.2.2 Observable characteristics of RIP test

Table 4.13 illustrates the observable characteristics present in the group as a whole, as well as for both SE groups separately, while performing the RIP test. The content of the table is arranged from high to low prevalence for both SH and SNH parameters.

Table 4.13: Results of observable characteristics of RIP test

			Head turn right			Head turn left		
			(n)	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*
SH Parameters	Able to assume posture fluently	Combined	85	70.83		87	72.50	
		HSES	44	73.33	0.55	43	71.67	0.84
		LSES	41	68.33		44	73.33	
	Head held steady	Combined	76	63.33		74	61.67	
		HSES	36	60.00	0.45	33	55.00	0.13
		LSES	40	66.67		41	68.33	
	Straight leg (0-45°)	Combined	67	55.83		79	65.83	
		HSES	33	55.00	0.85	38	63.33	0.56
		LSES	34	56.67		41	68.33	
	Straight back	Combined	58	48.33		76	63.33	
		HSES	27	45.00	0.47	38	63.33	1.00
		LSES	31	56.67		38	63.33	
	Elbow flexion present not more than 25°	Combined	51	42.50		50	41.67	
		HSES	27	45.00	0.60	30	50.00	0.06
		LSES	24	40.00		20	33.33	
	Head in line with back	Combined	43	35.83		52	43.33	
		HSES	16	26.67	0.04*	25	41.67	0.71
		LSES	27	45.00		27	45.00	
	Able to keep chin against shoulder	Combined	42	35.00		51	42.50	
		HSES	26	43.33	0.06	26	43.33	0.85
		LSES	16	26.67		25	41.67	
	Leg and knee in line with hip	Combined	24	20.00		23	19.17	
		HSES	13	21.67	0.65	10	16.67	0.49
		LSES	11	18.33		13	21.67	

*$p<0.05$

(Table 4.13: Results of observable characteristics of RIP test – continued)

			Head turn right			Head turn left		
			(n)	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*
SNH Parameters	Body sway	Combined	113	94.17		115	95.83	
		HSES	57	95.00	1.00	58	96.67	1.00
		LSES	56	93.33		57	95.00	
	Elbow flexion of contralateral arm	Combined	49	40.83		60	50.00	
		HSES	23	38.33	0.58	26	43.33	0.14
		LSES	26	43.33		34	56.67	
	Associated reactions with mouth	Combined	20	16.67		18	15.00	
		HSES	13	21.67	0.14	11	18.33	0.31
		LSES	7	11.67		7	11.67	
	Open shoulder and turn body	Combined	20	16.67		16	13.33	
		HSES	10	16.67	1.00	6	10.00	0.28
		LSES	10	16.67		10	16.67	
	Excessive lordosis of back	Combined	19	15.83		13	10.83	
		HSES	10	16.67	0.80	8	13.33	0.38
		LSES	9	15.00		5	8.33	
	Tends to lock elbows	Combined	17	14.17		14	11.67	
		HSES	10	16.67	0.43	9	15.00	0.26
		LSES	7	11.67		5	8.33	
	Retracts chin in body	Combined	7	5.83		10	8.33	
		HSES	3	5.00	1.00	4	6.67	0.51
		LSES	4	6.67		6	10.00	
	Resistance to head turning	Combined	7	5.83		9	7.50	
		HSES	4	6.67	1.00	4	6.67	1.00
		LSES	3	5.00		5	8.33	
	C-curve in back and shoulders	Combined	0	0.00		4	3.33	
		HSES	0	0.00	-	1	1.67	0.62
		LSES	0	0.00		3	5.00	

**p*<0.05

i) Describing the combined observable characteristics of the RIP test

Combined scores are shaded in light grey in Table 4.13.

<u>SH Parameters:</u>

The majority of the participants were able to *assume the posture fluently* both to the right (70.83%, n=85) and left (72.50%, n=87) sides.

When the *head was turned to the right*, 63.33% (n=76) of participants were able to *keep their head steady*, 55.83% (n=67) *had a straight leg*, 48.33% (n=58) had a *straight back* and 42.50% (n=51) had elbow flexion less than 25°. The rest of the SH parameters were observed in 35.83% (n=43) or less of participants when analysing the combined results (e.g. *head in line with back*).

When the head was *turned to the left side*, 61.67% (n=74) of participants were able to *keep their head steady*, 65.83% (n=79) *had a straight leg*, 63.33% (n=76) had *a straight back* and *elbow flexion present not more than 25°* was observed in 41.67% (n=50) of participants. The rest of the SH parameters were observed in 43.33% (n=52) [(e.g. *head in line with back*)] or less of participants when analysing the combined results.

<u>SNH Parameters:</u>

Body sway was observed in the majority of participants, when the head was turned to the *right* (94.14%, n=113) and *left* (95.83%, n=115). Forty point eight-three percent (40.83%) (n=49) of participants had *elbow flexion more than 25°* when the head was turned to the *right*, with more elbow flexion observed when the head was turned to the *left* (50.00%, n=60). The difference between the elbow flexion more than 25°, and elbow flexion less than 25°, are those participants that presented with no elbow flexion (8.33%, n=10). The rest of the SH parameters were observed in 16.67% (n=20) or less of participants when analysing the combined results (e.g. *associated reactions of the mouth*).

ii) Comparing the performance of SE groups on the observable characteristics of the RIP test

SH Parameters:

The only significant difference between the SE groups' performance on the RIP, was one SH parameter; *head in line with back* (p=0.04) when head was turned to the right side. This parameter was more prevalent in participants from LSES (45.00%, n=27) than HSES (26.67%, n=16).

SNH Parameters:

No significant differences between the SE groups' performance on the RIP was evident with regard to the SNH parameters.

4.3.5.3 STNR

4.3.5.3.1 Measurable characteristics of STNR test

Table 4.14 illustrates the results of the measurable characteristics present in the group as a whole, as well as for both SE groups separately, while performing the STNR test. The measurable characteristics included a grade score allocation and the degree of elbow flexion present when the head was flexed.

Table 4.14: Results of measurable characteristics of STNR test

	Grade 1		**Grade 2**		**Grade 3**		**Grade 4**		**Grade 5**		**Degree R (Q_1-Q_3)**	**Degree L (Q_1-Q_3)**	**Degree Range R**		**Degree Range L**		**Degree Median R**	**Degree Median L**	**Grade difference**	**Difference in degree**
	(n)	***(%)***	***(n)***	***(%)***	***(n)***	***(p)***	***(n)***	***(%)***	***(n)***	***(%)***	***(°)***	***(°)***	***(°)***	***(°)***	***(°)***	***(°)***	***(°)***	***(°)***	***(p)***	***(p)***
Combined	71	59.17	19	15.83	8	6.67	5	4.17	17	14.17	29.00-61.50	30.50-61.50	0	95.00	0	125.00	46.00	45.50		
HSES	34	56.67	11	18.33	3	5.00	3	5.00	9	15.00	29.50-59.50	29.50-58.00	0	95.00	0	107.00	45.00	42.00	0.85	0.98
LSES	37	61.67	8	13.33	5	8.33	2	3.33	8	13.33	28.00-62.50	33.00-65.00	0	84.00	0	125.00	47.00	48.50		

R: Right; L: Left

Q: Quartiles

*p<0.05

i) Describing the combined measurable characteristics of the STNR test

Combined scores are shaded in light grey in Table 4.14.

Fifty-nine point one-seven percent (59.17%) (n=71) of the participants obtained a grade score of 1 with only 14.17% (n=17) of the participants obtaining a grade score of 5.

The median degree of elbow flexion for the *right* side was *46.00°*, with a Q_1-Q_3 range of 29.00° - 61.50°. The median degree of elbow flexion for the *left* side was *45.50°*, with a Q_1-Q_3 range of 30.50° - 61.50°.

ii) Comparing the performance of SE groups on the measurable characteristics of the STNR test

No significant difference was found within the two SE groups' grade score (*p*=0.85) and degree of elbow flexion (*p*=0.98).

4.3.5.3.2 Observable characteristics of STNR test

Table 4.15 illustrates the observable characteristics present in the group as a whole, as well as for both SE groups separately while performing the STNR test. The content of the table is arranged from high to low prevalence for both SH and SNH parameters.

Table 4.15: Results of observable characteristics of STNR test

			Neck Flexion			Neck Extension		
			(n)	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*
SH Parameter	No changes in joint position of arms	Combined	14	11.67		74	61.67	
		HSES	10	16.67	0.08	40	66.67	0.26
		LSES	4	6.67		34	56.67	
SNH Parameters	Posterior pelvic tilt	Combined	102	85.00		0	0.00	
		HSES	52	86.67	0.61	0	0.00	-
		LSES	50	83.33		0	0.00	
	Rounded/arched back	Combined	101	84.17		0	0.00	
		HSES	51	85.00	0.80	0	0.00	-
		LSES	50	83.33		0	0.00	
	Elbow flexion more than 25°	Combined	98	81.67		0	0.00	
		HSES	48	80.00	0.62	0	0.00	-
		LSES	50	83.33		0	0.00	

**p*<0.05

(Table 4.15: Results of observable characteristics of STNR test – continued)

			Neck Flexion			Neck Extension		
			(n)	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*
SNH Parameters	Anterior pelvic tilt	Combined	0	0.00		113	94.17	
		HSES	0	0.00	-	55	91.67	0.44
		LSES	0	0.00		58	96.67	
	Lordosis of back	Combined	0	0.00		111	92.50	
		HSES	0	0.00	-	53	88.33	0.16
		LSES	0	0.00		58	96.67	
	Excessive extension of elbows	Combined	0	0.00		85	70.83	
		HSES	0	0.00	-	41	68.33	0.55
		LSES	0	0.00		44	73.33	
	Tends to lock elbows	Combined	53	44.17		40	33.33	
		HSES	26	43.33	0.85	19	31.67	0.70
		LSES	27	45.00		21	35.00	
	Resistance to head turning	Combined	31	25.83		32	26.67	
		HSES	20	33.33	0.06	23	38.33	0.00*
		LSES	11	18.33		9	15.00	

*$p<0.05$

i) Describing the combined observable characteristics of the STNR test

Combined scores are shaded in light grey in Table 4.15.

<u>SH Parameters:</u>

During *neck flexion*, only 11.67% (n=14) of the participants *had no changes in joint position,* referring to flexion of elbows. Furthermore, 61.67% (n=74) of the participants had *no changes in joint position* during *neck extension.*

<u>SNH Parameters:</u>

During *neck flexion*, *elbow flexion more than 25°* was observed in 81.67% (n=98) of the participants. The difference between no changes in joint position and elbow flexion more than 25°, indicate participants with elbow flexion present, but less than 25° (6.67%, n=8). Eighty-five percent (85.00%) (n=102) of the participants presented with *a posterior pelvic tilt* and 84.17% (n=101) had a *rounded/arched back*.

During *neck extension*, 94.17% (n=113) of the participants had *an anterior pelvic tilt* with 92.50% (n=111) presenting with *lordosis* of the back.

Excessive elbow extension was observed among 70.83% (n=85) of the participants and 33.33% (n=40) *locked their elbows*.

ii) Comparing the performance of SE groups on the observable characteristics of the STNR test

The only significant difference between the SE groups' performance on the STNR test, was one SNH parameter, *resistance to head turn* (*p*=0.00), as it was more observed in participants from HSES (38.33%, n=23) compared to those from LSES (15.00%, n=9).

4.3.6 Supine Flexion Posture (SFP)

4.3.6.1 Measurable characteristics of SFP test

Table 4.16 illustrates the results of the measurable characteristics present in the group as a whole, as well as for both SE groups separately, while performing the SFP test. The measurable characteristics included a grade score allocation and the duration in seconds to maintain the SFP.

Table 4.16: Results of measurable characteristics of SFP test

	Grade 1		**Grade 2**		**Grade 3**		**Grade 4**		**Grade 5**		**Duration (Q_1-Q_3)**	**Duration Range**		**Duration Median**	**Grade difference**	**Duration difference**
	(n)	***(%)***	***(n)***	***(%)***	***(n)***	***(%)***	***(n)***	***(%)***	***(n)***	***(%)***	***(sec)***	***(sec)***	***(sec)***	***(sec)***	***(p)***	***(p)***
Combined	4	3.33	20	16.67	26	21.67	45	37.50	25	20.83	10.50-25.00	3.00	78.00	16.00		
HSES	2	3.33	5	8.33	16	26.67	22	36.67	15	25.00	11.00-27.50	4.00	72.00	18.00	0.12	0.18
LSES	2	3.33	15	25.00	10	16.67	23	38.33	10	16.67	8.50-23.00	3.00	78.00	15.50		

Q: Quartiles
*$p<0.05$

i) Describing the combined measurable characteristics of the SFP test

Combined scores are shaded in light grey in Table 4.16.

The majority of the participants obtained a grade score of 4 (37.50%, n=45) and only 3.33% (n=4) of participants obtained a grade score of 1. The median seconds to maintain the SFP were *16.00* seconds, with a Q_1-Q_3 range of 10.50-25.00 seconds.

ii) Comparing the performance of SE groups on the measurable characteristics of the SFP test

No significant difference between the two SE groups was evident on the SFP, with regard to the grade scores (*p*=0.12) and duration (*p*=0.18).

4.3.6.2 Observable Characteristics of SFP test

Table 4.17 illustrates the observable characteristics present in the group as a whole, as well as for both SE groups separately, while performing the SFP test. The content of the table is arranged from high to low prevalence for both SH and SNH parameters.

Table 4.17: Results of observable characteristics of SFP test

		SES	*(n)*	*(%)*	*(p)*
SH Parameters	Lifts limbs simultaneously	Combined	63	52.50	
		HSES	29	48.33	0.36
		LSES	34	56.67	
	Can keep legs and neck against resistance	Combined	53	44.17	
		HSES	30	50.00	0.20
		LSES	23	38.33	
	C-curve in upper trunk (shoulder and back)	Combined	52	43.33	
		HSES	27	45.00	0.71
		LSES	25	41.67	
	Neck flexion ≥ 45°	Combined	36	30.00	
		HSES	22	36.67	0.11
		LSES	14	23.33	
	Head held steady	Combined	28	23.33	
		HSES	15	25.00	0.67
		LSES	13	21.67	
SNH Parameters	Effort required	Combined	103	85.83	
		HSES	52	86.67	0.79
		LSES	51	85.00	
	Shoulder elevation	Combined	90	75.00	
		HSES	42	70.00	0.21
		LSES	48	80.00	
	Fixation of upper limbs	Combined	88	73.33	
		HSES	40	66.67	0.10
		LSES	48	80.00	

*p<0.05

(Table 4.17: Results of observable characteristics of SFP test – continued)

		SES	(n)		(%)		(p)
SNH Parameters	Neck flexion less than 45°	Combined	84		70.00		
		HSES	39		65.00		0.23
		LSES	45		75.00		
	Retracts chin in body	Combined	74		61.67		
		HSES	33		55.00		0.13
		LSES	41		68.33		
	Press feet together	Combined	70		58.33		
		HSES	32		53.33		0.27
		LSES	38		63.33		
	Trunk and shoulders in line (no definite curve present)	Combined	68		56.67		
		HSES	33		55.00		0.71
		LSES	35		58.33		
	Head lag before 10 seconds	Combined	60		50.00		
		HSES	25		41.67		0.07
		LSES	35		58.33		
	Assumes posture segmented	Combined	UL 4	LL 53	UL 3.33	LL 44.17	
		HSES	UL 0	LL 31	UL 0.00	LL 51.67	0.05
		LSES	UL 4	LL 22	UL 6.67	LL 36.67	
	Fixation of lower limbs	Combined	52		43.33		
		HSES	23		38.33		0.27
		LSES	29		48.33		
	Placing one foot over the other	Combined	43		35.83		
		HSES	25		41.67		0.18
		LSES	18		30.00		
	Unable to count aloud	Combined	28		23.33		
		HSES	6		10.00		0.00*
		LSES	22		36.67		
	Grabbing onto clothes	Combined	26		21.67		
		HSES	13		21.67		1.00
		LSES	13		21.67		
	Chin lead	Combined	14		11.67		
		HSES	5		8.33		0.26
		LSES	9		15.00		
	Fisting of hands	Combined	4		3.33		
		HSES	0		0.00		0.04
		LSES	4		6.67		
	Associated reaction with mouth	Combined	4		3.33		
		HSES	2		3.33		1.00
		LSES	2		3.33		

UL: Upper Limbs; LL: Lower Limbs
*$p<0.05$

i) Describing the combined observable characteristics of the SFP test

Combined scores are shaded in light grey in Table 4.17.

SH Parameters:

Fifty-two and a half percent (52.50%) (n=63) of the participants were able to *simultaneously lift both upper and lower limbs* and 44.17% (n=53) were able to keep the *posture against resistance*. A *c-curve in the upper trunk* was observed in 43.33% (n=52) of participants and 30.00% (n=36) had *neck flexion less than 45°*.

SNH Parameters:

High occurrence of several SNH parameters were observed during the SFP test. Eighty-five point eight-three percent (85.83%) (n=103) of the participants required *effort* to maintain the posture, with *shoulder elevation* observed in 75.00% (n=90) of the participants. *Fixation of upper limbs* were observed among 73.33% (n=88) of the participants with 70.00% (n=84) presenting with *neck flexion less than 45°*. *Retracting chin in body* was observed in 61.67% (n=74) of the participants and 58.33% (n=70) *pressed their feet together.*

All other SNH parameters were observed in 56.67% (n=68) or less of participants when analysing the combined results (e.g. *trunk and shoulders in line).*

ii) Comparing the performance of SE groups on the observable characteristics of the SFP test

The only significant difference between the SE groups' performance on the SFP test, was one SNH parameter, *unable to count aloud* (p=0.00). This was observed more in participants from LSES (36.67%, n=22) compared to participants from HSES (10.00%, n=6).

4.3.7 Schilder's Arm Extension (SAE)

4.3.7.1 Measurable characteristics of SAE test

Table 4.18 illustrates the results of the measurable characteristics present in the group as a whole, as well as for both SE groups separately, while performing the SAE test. The measurable characteristics included a grade score allocation.

Table 4.18: Results of measurable characteristics of SAE test

	Grade 1		Grade 2		Grade 3		Grade 4		Grade 5		Grade difference
	(n)	*(%)*	*(n)*	*(%)*	*(n)*	*(%)*	*(n)*	*(%)*	*(n)*	*(%)*	*(p)*
Combined	8	6.67	35	29.17	40	33.33	30	25.00	7	5.83	
HSES	4	6.67	17	28.33	18	30.00	18	30.00	3	5.00	0.79
LSES	4	6.67	18	30.00	22	36.67	12	20.00	4	6.67	
*$p<0.05$											

i) Describing the combined measurable characteristics of the SAE test

Combined scores are shaded in light grey in Table 4.18.

A grade score of 3 was obtained by the majority of the participants (33.33%, n=40), followed by a grade score of 2 (29.17%, n=35).

ii) Comparing the performance of SE groups on the measurable characteristics of the SAE test

No significant difference (p=0.79) was found on the grade scores for the two SE groups on the SAE test.

4.3.7.2 Observable Characteristics of SAE test

Table 4.19 illustrates the observable characteristics present in the group as a whole, as well as for both SE groups separately, while performing the SAE test. The content of the table is arranged from high to low prevalence for both SH and SNH parameters.

Table 4.19: Results of observable characteristics of SAE test

			Static			**Head turn**		
			(n)	***(%)***	***(p)***	***(n)***	***(%)***	***(p)***
SH Parameters	Maintains balance when eyes are closed	Combined	119	99.17		120	100.00	
		HSES	59	98.33	1.00	60	100.00	-
		LSES	60	100.00		60	100.00	
	Dissociate head from trunk	Combined				59	49.16	
		HSES				31	51.67	0.36
		LSES				28	46.67	
	No changes in upper limbs	Combined	98	81.67		3	2.50	
		HSES	50	83.33	0.64	3	5.00	0.08
		LSES	48	80.00		0	0.00	
SNH Parameters	Elevation of shoulders	Combined	82	68.33		59	49.17	
		HSES	41	68.33	1.00	32	53.33	0.36
		LSES	41	68.33		27	45.00	
	Fixation of arms	Combined	79	65.83		66	55.00	
		HSES	41	68.33	0.56	29	48.33	0.14
		LSES	38	63.33		37	61.67	
	Retracts chin in body	Combined	62	51.67		25	20.83	
		HSES	30	50.00	0.71	11	18.33	0.50
		LSES	32	53.33		14	23.33	
	No opening between fingers	Combined	51	42.50		49	40.83	
		HSES	21	35.00	0.10	25	41.67	0.85
		LSES	30	50.00		24	40.00	
	Involuntary movements of fingers	Combined	27	22.50		18	15.00	
		HSES	15	25.00	0.51	12	20.00	0.11
		LSES	12	20.00		6	10.00	

*$p<0.05$

(Table 4.19: Results of observable characteristics of SAE test – continued)

<table>
<tr><th colspan="3"></th><th colspan="3">Static</th><th colspan="5">Head turn</th></tr>
<tr><th colspan="3"></th><th>(n)</th><th>(%)</th><th>(p)</th><th colspan="2">(n)</th><th colspan="2">(%)</th><th>(p)</th></tr>
<tr><td rowspan="22">SNH Parameters</td><td rowspan="3">Touching hands to stabilise arms</td><td>Combined</td><td>16</td><td>13.33</td><td></td><td colspan="2">12</td><td colspan="2">10.00</td><td></td></tr>
<tr><td>HSES</td><td>9</td><td>15.00</td><td rowspan="2">0.59</td><td colspan="2">3</td><td colspan="2">5.00</td><td rowspan="2">0.07</td></tr>
<tr><td>LSES</td><td>7</td><td>11.67</td><td colspan="2">9</td><td colspan="2">15.00</td></tr>
<tr><td rowspan="3">Arms separate</td><td>Combined</td><td>6</td><td>5.00</td><td></td><td colspan="2">40</td><td colspan="2">33.33</td><td></td></tr>
<tr><td>HSES</td><td>2</td><td>3.33</td><td rowspan="2">0.68</td><td colspan="2">21</td><td colspan="2">35.00</td><td rowspan="2">0.70</td></tr>
<tr><td>LSES</td><td>4</td><td>6.67</td><td colspan="2">19</td><td colspan="2">31.67</td></tr>
<tr><td rowspan="3">Horizontal deviation of the arms > 45°</td><td>Combined</td><td rowspan="3" colspan="3"></td><td colspan="2">90</td><td colspan="2">75.00</td><td></td></tr>
<tr><td>HSES</td><td colspan="2">42</td><td colspan="2">70.00</td><td rowspan="2">0.21</td></tr>
<tr><td>LSES</td><td colspan="2">48</td><td colspan="2">80.00</td></tr>
<tr><td rowspan="4">Trunk rotation</td><td></td><td rowspan="4" colspan="3"></td><td>>45°</td><td><45°</td><td>>45°</td><td><45°</td><td></td></tr>
<tr><td>Combined</td><td>61</td><td>59</td><td>50.83</td><td>49.16</td><td></td></tr>
<tr><td>HSES</td><td>29</td><td>31</td><td>48.33</td><td>51.67</td><td rowspan="2">0.58</td></tr>
<tr><td>LSES</td><td>32</td><td>28</td><td>53.33</td><td>46.67</td></tr>
<tr><td rowspan="3">Resistant to head turning</td><td>Combined</td><td rowspan="3" colspan="3"></td><td colspan="2">5</td><td colspan="2">4.17</td><td></td></tr>
<tr><td>HSES</td><td colspan="2">3</td><td colspan="2">5.00</td><td rowspan="2">1.00</td></tr>
<tr><td>LSES</td><td colspan="2">2</td><td colspan="2">3.33</td></tr>
<tr><td rowspan="3">Associated reactions with the mouth</td><td>Combined</td><td>4</td><td>3.33</td><td></td><td colspan="2">1</td><td colspan="2">0.83</td><td></td></tr>
<tr><td>HSES</td><td>3</td><td>5.00</td><td rowspan="2">0.60</td><td colspan="2">1</td><td colspan="2">1.67</td><td rowspan="2">1.00</td></tr>
<tr><td>LSES</td><td>1</td><td>1.67</td><td colspan="2">0</td><td colspan="2">0.00</td></tr>
<tr><td rowspan="3">Dislike having eyes closed</td><td>Combined</td><td>0</td><td>0.00</td><td></td><td colspan="2">0</td><td colspan="2">0.00</td><td></td></tr>
<tr><td>HSES</td><td>0</td><td>0.00</td><td rowspan="2">0.00</td><td colspan="2">0</td><td colspan="2">0.00</td><td rowspan="2">0.00</td></tr>
<tr><td>LSES</td><td>0</td><td>0.00</td><td colspan="2">0</td><td colspan="2">0.00</td></tr>
<tr><td colspan="11">> more; < less
*p<0.05</td></tr>
</table>

(Table 4.19: Results of observable characteristics of SAE test – continued)

			Static							Head turn						
			(n)			***(%)***			***(p)***	***(n)***			***(%)***			***(p)***
SNH Parameters	Starting position of arms more than 90°		R	L	B	R	L	B		R	L	B	R	L	B	
		Combined	1	1	26	0.83	0.83	21.67		1	0	15	0.83	0.00	12.50	
		HSES	1	0	14	1.67	0.00	23.33	0.41	1	0	7	1.67	0.00	11.67	1.00
		LSES	0	1	12	0	0.00	20.00		0	0	8	0.00	0.00	13.33	
	Starting position of arms less than 90°		R	L	B	R	L	B		R	L	B	R	L	B	
		Combined	0	0	3	0.00	0.00	1.37		0	0	3	0.00	0.00	2.50	
		HSES	0	0	2	0	0	3.33	1.00	0	0	0	0.00	0.00	0.00	0.24
		LSES	0	0	1	0.00	0.00	1.67		0	0	3	0.00	0.00	5.00	
	Arms drop less than 45° (from 90°)		R	L	B	R	L	B		R	L	B	R	L	B	
		Combined	1	1	2	0.83	0.83	1.67		4	9	39	3.33	7.50	32.50	
		HSES	1	0	1	1.67	0.00	1.67	1.00	2	4	18	3.33	6.67	30.00	0.91
		LSES	0	1	1	0.00	1.67	1.67		2	5	21	3.33	8.33	35.00	
	Arms drop more than 45° (from 90°)		R	L	B	R	L	B		R	L	B	R	L	B	
		Combined	0	0	2	0.00	0.00	1.67		2	0	31	1.67	0.00	25.83	
		HSES	0	0	1	0.00	0.00	1.67	1.00	1	0	18	1.67	0.00	30.00	0.70
		LSES	0	0	1	0.00	0.00	1.67		1	0	13	1.67	0.00	21.67	
	Arms raised less than 45° (from 90°)		R	L	B	R	L	B		R	L	B	R	L	B	
		Combined	1	1	3	0.83	0.83	2.50		1	0	4	0.83	0.00	3.33	
		HSES	0	0	1	0.00	0.00	1.67	0.43	1	0	0	1.67	0.00	0.00	0.12
		LSES	1	1	2	1.67	1.67	3.33		0	0	4	0.00	0.00	6.67	
	Arms raised more than 45° (from 90°)		R	L	B	R	L	B		R	L	B	R	L	B	
		Combined	1	1	3	0.83	0.83	2.50		0	0	1	0.00	0.00	0.83	
		HSES	0	0	3	0.00	0.00	5.00	0.24	0	0	1	0.00	0.00	1.67	1.00
		LSES	1	1	0	1.67	1.67	0.00		0	0	0	0.00	0.00	0.00	
	Spoon hands		R	L	B	R	L	B		R	L	B	R	L	B	
		Combined	7	11	26	5.83	9.17	21.67		1	9	33	0.83	7.50	27.50	
		HSES	3	6	15	5.00	10.00	25.00	0.83	0	5	19	0.00	8.33	31.67	0.59
		LSES	4	5	11	6.67	8.33	18.33		1	4	14	1.67	6.67	23.33	

R: Right; L: Left; B: Both
*$p<0.05$

(Table 4.19: Results of observable characteristics of SAE test – continued)

			STATIC							HEAD TURN						
			(n)			*(%)*			*(p)*	*(n)*			*(%)*			*(p)*
SNH Parameters	Able to correct positioning of upper arms		R	L	B	R	L	B		R	L	B	R	L	B	
		Combined	0	0	2	0.00	0.00	1.67		1	0	33	0.83	0.00	27.50	
		HSES	0	0	1	0.00	0.00	1.67	1.00	0	0	15	0.00	0.00	25.00	0.48
		LSES	0	0	1	0.00	0.00	1.67		1	0	18	1.67	0.00	30.00	
	Flexion of elbows		R	L	B	R	L	B		R	L	B	R	L	B	
		Combined	0	0	0	0.00	0.00	0.00		3	1	3	2.50	0.83	2.50	
		HSES	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0.00	0.00	0.00	0.01*
		LSES	0	0	0	0.00	0.00	0.00		3	1	3	5.00	1.67	5.00	
	Thumb to palm not next to index finger		R	L	B	R	L	B		R	L	B	R	L	B	
		Combined	0	1	12	0.00	0.83	10.00		0	1	10	0.00	0.83	8.33	
		HSES	0	0	6	0.00	0.00	10.00	1.00	0	0	4	0.00	0.00	6.67	0.53
		LSES	0	1	6	0.00	1.67	10.00		0	1	6	0.00	1.67	10.00	
	Hand drop		R	L	B	R	L	B		R	L	B	R	L	B	
		Combined	2	4	9	1.67	3.33	7.50		2	4	7	1.67	3.33	5.83	
		HSES	1	2	4	1.67	3.33	6.67	0.99	2	2	3	3.33	3.33	5.00	0.69
		LSES	1	2	5	1.67	3.33	8.33		0	2	4	0.00	3.33	6.67	
	Asymmetry		R	L		R	L			R	L		R	L		
		Combined	11	5		9.17	4.17			19	26		15.83	21.67		
		HSES	5	2		8.33	3.33		0.85	8	17		13.33	28.33		0.20
		LSES	6	3		10.00	5.00			11	9		18.33	15.00		

R: Right; L: Left; B: Both
*$p<0.05$

i) Describing the combined observable characteristics of the SAE test

Combined scores are shaded in light grey in Table 4.19.

SH Parameters:

For the *static position* (cf. Appendix I), 81.67% (n=98) of the participants had *no changes in joint positions of the upper limbs* and 99.17% (n=119) were *able to keep their balance*.

For the *head turn position* (cf. Appendix I), only 2.50% (n=3) of the participants had no *changes in joint position* (upper limbs did not stay in the original position), 49.16% (n=59) were able to *dissociate their head from the trunk* and all the participants were able to *maintain balance* while vision was occluded (100.00%, n=120).

SNH Parameters:

During the *static position*, 68.33% (n=82) of the participants had *shoulder elevation*, 65.83% (n=79) *fixated their arms*, 51.67% (n=62) *retracted their chin* and 42.50% (n=51) had *no opening between the fingers.* All other SNH parameters were observed in 22.50% (n=27) or less of participants when analysing the combined results (e.g. *involuntary movements of the fingers*).

During the *head turn position*, 75.00% (n=90) of the participants presented with *horizontal arm deviation more than 45°.* Fifty-five percent (55.00%) (n=66) of the *participants fixated their arms* and 50.83% (n=61) had *trunk rotation more than 45°.* All other SNH parameters were observed in 49.17% (n=59) or less of participants when analysing the combined results (e.g. *shoulder elevation*).

ii) Comparing the performance of SE groups on the observable characteristics of the SAE test

None of the parameters except *flexion of elbows* had a significant difference (p=0.01) between the two SE groups, when the head was turned, as the parameter was observed more in participants from LSES group (right arm 5.00%, n=3; left arm 1.67%, n=1 and both arms 5.00%, n=3), compared to HSES (0.00%, n=0).

4.3.8 Finger-To-Nose (FTN)

4.3.8.1 Measurable Characteristics of FTN test

Table 4.20 illustrates the results of the measurable characteristics present in the group as a whole, as well as for both SE groups separately, while performing the FTN test. The measurable characteristics included a grade score allocation.

Table 4.20: Results of measurable characteristics of FTN test

	Grade 1		Grade 2		Grade 3		Grade 4		Grade 5		Grade difference
	(n)	*(%)*	*(n)*	*(%)*	*(n)*	*(%)*	*(n)*	*(%)*	*(n)*	*(%)*	*(p)*
Combined	4	3.33	29	14.17	22	18.33	42	35.00	23	19.17	
HSES	1	1.67	18	30.00	12	20.00	19	31.67	10	16.67	0.46
LSES	3	5.00	11	18.33	10	16.67	23	38.33	13	21.67	
*$p<0.05$											

i) Describing the combined measurable characteristics of the FTN test

Combined scores are shaded in light grey in Table 4.20.

Thirty-five percent (35.00%) (n=42) of the participants obtained a grade score of 4 and only 3.33% (n=4) obtained a grade score of 1.

ii) Comparing the performance of SE groups on the measurable characteristics of the FTN test

No significant difference (p=0.46) on the performance of the two SE groups on the measurable characteristics of the FTN test, was evident.

4.3.8.2 Observable Characteristics of FTN test

Table 4.21 illustrates the observable characteristics present in the group as a whole, as well as for both SE groups separately, while performing the FTN test. The content of the table is arranged from high to low prevalence for both SH and SNH parameters.

Table 4.21: Results of observable characteristics of FTN test

			Right			Left		
			(n)	***(%)***	***(p)***	***(n)***	***(%)***	***(p)***
SH Parameters	Arms abducted 90°	Combined	83	69.17		86	71.67	
		HSES	41	68.33	0.84	43	71.67	1.00
		LSES	42	70.00		43	71.67	
	Fluid and smooth movement	Combined	82	68.33		84	70.00	
		HSES	43	71.67	0.43	45	75.00	0.23
		LSES	39	65.00		39	65.00	
	Touch tip of nose within 1.5 cm	Combined	77	64.17		79	65.83	
		HSES	38	63.33	0.85	37	61.67	0.34
		LSES	39	65.00		42	70.00	
	Miss tip of nose able to correct	Combined	7	5.83		13	10.83	
		HSES	5	8.33	0.44	10	16.67	0.04*
		LSES	2	3.33		3	5.00	
SNH Parameters	Press hard on nose	Combined	85	70.83		85	70.83	
		HSES	43	71.67	0.84	44	73.33	0.55
		LSES	42	70.00		41	68.33	
	Touch nose not with tip of finger	Combined	46	38.33		42	35.00	
		HSES	24	40.00	0.71	24	40.00	0.25
		LSES	22	36.67		18	30.00	
	Retracts chin	Combined	35	29.17		34	24.83	
		HSES	12	20.00	0.03*	12	20.00	0.04*
		LSES	23	38.33		22	36.67	
	Poor rhythm	Combined	18	15.00		16	13.33	
		HSES	10	16.67	0.61	9	15.00	0.59
		LSES	8	13.33		7	11.67	

*$p<0.05$

(Table 4.21: Results of observable characteristics of FTN test – continued)

			Right			Left		
			(n)	***(%)***	***(p)***	***(n)***	***(%)***	***(p)***
SNH Parameters	Non touching arm flexed 45° or more	Combined	18	15.00		18	15.00	
		HSES	7	11.67	0.31	8	13.33	0.61
		LSES	11	18.33		10	16.67	
	Turn head to the sides while touching nose	Combined	10	8.33		12	10.00	
		HSES	5	8.33	1.00	7	11.67	0.54
		LSES	5	8.33		5	8.33	
	Fixate upper limbs	Combined	6	5.00		6	5.00	
		HSES	4	6.67	0.68	4	6.67	0.68
		LSES	2	3.33		2	3.33	
	Replace finger with opposite hand	Combined	5	4.17		5	4.17	
		HSES	3	5.00	1.00	3	5.00	1.00
		LSES	2	3.33		2	3.33	
	Associated reactions with the mouth	Combined	5	4.17		5	4.17	
		HSES	4	6.67	0.36	4	6.67	0.36
		LSES	1	1.67		1	1.67	
	Loses rhythm	Combined	4	3.33		4	3.33	
		HSES	2	3.33	1.00	2	3.33	1.00
		LSES	2	3.33		2	3.33	

*$p<0.05$

i) Describing the combined observable characteristics of the FTN test

Combined scores are shaded in light grey in Table 4.21.

SH Parameters:

Fluid and smooth movement was observed (right hand 68.33%, n=82 and left hand 70.00%, n=84) and the participants were able to *touch the tip of their nose within 1.5 cm* (64.17% to 65.83%, n=77-79). *Miss the tip of the nose and able to correct it* were seldom observed (5.83% to 10.83%, n=7-13).

SNH Parameters:

The findings indicated that 70.83% (n=85) of the participants *pressed hard on the nose* with both right and left hands. Thirty-eight point three-three percent (38.33%) (n=46) of the participants did not *touch the nose with the tip* of the right finger and observed in 35.00% (n=42) of participants when performing with the left finger. All other SNH parameters were observed in 29.17% (n=35) or less of participants when analysing the combined results (e.g., *retracting chin*).

ii) Comparing the performance of SE groups on the observable characteristics of the FTN test

SH Parameters:

A significant difference (p=0.04) was found on one SH parameter for the left hand, *miss tip of nose and able to correct position*. Sixteen point six-seven percent (16.67%) (n=10) of participants from HSES were able to correct themselves. However, only 5.00% (n=3) of participants from the LSES group, were able to correct their finger position.

SNH Parameters:

A significant difference was found in one SNH parameter, *retracts chin in body* for the right (p=0.03) and left hand (p=0.04). This parameter was observed more in participants from LSES (right hand 38.33%, n=23 and left hand 36.67%, n=22), compared to HSES (20.00%, n=12 prevalence in both right and left hands).

4.3.9 Gaze Stability (GS)

4.3.9.1 Measurable Characteristics of GS test

Table 4.22 illustrates the results of the measurable characteristics present in the group as a whole, as well as for both SE groups separately while performing the GS test. The measurable characteristics included a grade score allocation.

Table 4.22: Results of measurable characteristics of GS test

	Grade 1		Grade 2		Grade 3		Grade 4		Grade 5		Grade difference
	(n)	*(%)*	*(n)*	*(%)*	*(n)*	*(%)*	*(n)*	*(%)*	*(n)*	*(%)*	*(p)*
Combined	3	2.50	11	9.17	36	30.00	48	40.00	22	18.33	
HSES	0	0.00	5	8.33	18	30.00	22	36.67	15	25.00	0.18
LSES	3	5.00	6	10.00	18	30.00	26	43.33	7	11.67	

**p*<0.05

i) Describing the combined measurable characteristics of the GS test

Combined scores are shaded in light grey in Table 4.22.

Forty percent (n=48) of the participants obtained a grade score of 4 with 2.50% (n=3) obtaining a grade score of 1.

ii) Comparing the performance of SE groups on the measurable characteristics of the GS test

No significant difference (*p*=0.18) on the performance of the two SE groups on the measurable characteristics of the GS test was evident.

4.3.9.2 Observable Characteristics of GS test

Table 4.23 illustrates the observable characteristics present in the group as a whole, as well as for both SE groups separately while performing the GS test. The content of the table is arranged from high to low prevalence for both SH and SNH parameters.

Table 4.23: Results of observable characteristics of GS test

			Head vertical			Head horizontal		
			(n)	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*
SH Parameters	Smooth bilateral coordination of eyes	Combined	110	91.67		108	90.00	
		HSES	57	95.00	0.19	55	91.67	0.54
		LSES	53	88.33		53	88.33	
	Eye movement independent from head movement	Combined	100	83.33		104	86.68	
		HSES	53	88.33	0.14	55	91.67	0.11
		LSES	47	78.33		49	81.67	
	Stable gaze when head moves	Combined	96	80.00		97	80.83	
		HSES	51	85.00	0.17	53	88.33	0.04*
		LSES	45	75.00		44	73.33	
	Smooth movement of head	Combined	50	41.67		53	44.17	
		HSES	30	50.00	0.06	31	51.67	0.10
		LSES	20	33.33		22	36.67	
SNH Parameters	Fixation of upper limbs	Combined	57	47.50		57	47.50	
		HSES	25	41.67	0.20	24	40.00	0.10
		LSES	32	53.33		33	55.00	
	Don't move head through full range of motion	Combined	37	30.83		39	32.50	
		HSES	18	30.00	0.84	20	33.33	0.85
		LSES	19	31.67		19	31.67	

*$p<0.05$

(Table 4.23: Results of observable characteristics of GS test – continued)

			Head vertical			Head horizontal		
			(n)	***(%)***	***(p)***	***(n)***	***(%)***	***(p)***
SNH Parameters	Over-exaggerated movement of head	Combined	32	26.67		17	14.17	
		HSES	13	21.67	0.22	3	5.00	0.00*
		LSES	19	31.67		14	23.33	
	Slow movement	Combined	25	20.83		7	5.83	
		HSES	12	20.00	0.82	4	6.67	0.70
		LSES	13	21.67		3	5.00	
	Uncoordinated action	Combined	16	13.33		33	27.50	
		HSES	3	5.00	0.01*	15	25.00	0.54
		LSES	13	21.67		18	30.00	
	Associated reactions with the mouth	Combined	15	12.50		17	14.17	
		HSES	9	15.00	0.41	9	15.00	0.79
		LSES	6	10.00		8	13.33	
	Lose eye contact when object is in peripheral vision	Combined				36	30.00	
		HSES				13	21.67	0.05*
		LSES				23	38.33	

*$p<0.05$

i) Describing the combined observable characteristics of the GS test

Combined scores are shaded in light grey in Table 4.23.

SH Parameters:

Smooth bilateral coordination of the eyes were observed in the participants (90.00% to 91.67%, n=108-110), along with *independent eye movements* (83.33% to 86.68%, n=100-104) and a *stable gaze* (80.00% to 80.83%, n=96-97).

SNH Parameters:

Fixation of upper limbs were observed in 47.50% (n=57) of participants while moving the head in both directions. All other SNH parameters were observed in 32.50% (n=39) or less of participants when analysing the combined results (e.g., *did not move head through full range of motion*).

ii) Comparing the performance of SE groups on the observable characteristics of the GS test

SH Parameters:

One SH parameter, *stable gaze* when head moves horizontally had a significant difference (p=0.04) between the SE groups, as the parameter was present more in participants from the HSES group (83.33%, n=53), compared to participants from the LSES group (73.33%, n=44).

SNH Parameters:

A significant difference was found for *over-exaggerated movement of the head* horizontally (p=0.00), *uncoordinated movement* (p=0.01) and *lose eye contact* when the object is in peripheral vision (p=0.05). More participants from LSES (23.33%, n=14) had *over-exaggerated head movement*, compared to HSES (5.00%, n=3). Similar results were found for *uncoordinated action*, as it was more prevalent in participants from LSES (21.67%, n=13) than participants from HSES (5.00%, n=3). Participants from LSES (38.33%, n=23) more frequently *lost eye contact with the object*, compared to participants from HSES (21.67%, n=13).

4.3.10 Standing Balance (SB)

4.3.10.1 Measurable Characteristics of SB test

Table 4.24 illustrates the results of the measurable characteristics present in the group as a whole, as well as for both SE groups separately while performing the SB test. The measurable characteristics included a grade score allocation and the duration in seconds to maintain balance on the right and left legs with eyes open and closed.

Table 4.24: Results of measurable characteristics of SB test

		Grade 1		Grade 2		Grade 3		Grade 4		Grade 5		Time (Q_1-Q_3)	Time Range		Time (Median)	Grade difference	Time difference
		(n)	*(%)*	*(n)*	*(%)*	*(n)*	*(p)*	*(n)*	*(%)*	*(n)*	*(%)*	*(sec)*	*(sec)*	*(sec)*	*(sec)*	*(p)*	*(p)*
Eyes open Right leg	Combined	6	5.00	21	17.50	20	16.67	15	12.50	58	48.33	5.00-17.50	2.00	111.00	9.50		
	HSES	3	5.00	7	11.67	10	16.67	9	15.00	31	51.67	5.50-17.50	2.00	11.00	10.00	0.52	0.62
	LSES	3	5.00	14	23.33	10	16.67	6	10.00	27	45.00	4.00-18.00	2.00	59.00	9.00		
Eyes open Left leg	Combined	9	7.50	12	10.00	19	15.83	18	15.00	62	51.67	6.00-22.00	1.00	132.00	10.50		
	HSES	4	6.67	2	3.33	7	11.67	8	13.33	39	65.00	8.00-24.50	2.00	126.00	12.50	0.03*	0.03*
	LSES	5	8.33	10	16.67	12	20.00	10	16.67	23	38.33	4.50-17.50	1.00	132.00	9.00		
Eyes closed Right leg	Combined	42	35.29	40	33.61	20	16.81	9	7.56	9	7.56	1.00-4.00	1.00	18.00	2.00		
	HSES	19	31.67	20	33.33	12	20.00	5	8.33	4	6.67	1.50-4.00	1.00	18.00	2.00	0.87	0.79
	LSES	23	38.98	20	33.90	8	13.56	4	6.78	5	8.33	1.00-4.00	1.00	15.00	2.00		
Eyes closed Left leg	Combined	35	29.17	50	41.67	17	14.17	8	6.67	10	8.33	2.00-4.00	1.00	15.00	2.00		
	HSES	16	26.67	19	31.67	13	21.67	5	8.33	7	11.67	2.00-4.00	1.00	15.00	2.50	0.04*	0.12
	LSES	19	31.67	31	51.67	4	6.67	3	5.00	3	5.00	1.00-2.00	1.00	15.00	2.00		

Q: Quartiles
**p*<0.05

i) Describing the combined measurable characteristics of the SB test

Combined scores are shaded in light grey in Table 4.24.

During *balance on the right leg with eyes open,* 48.33% (n=58) of the participants obtained a grade score of 5. The median seconds to balance on the right leg with eyes open were *9.50* seconds, with a Q_1-Q_3 range of 5.00-17.50 seconds.

With the *left leg*, 51.67% (n=62) of participants obtained a grade score of 5. The median seconds to balance on the left leg with eyes open were *10.50* seconds, with a Q_1-Q_3 range of 6.00-22.00 seconds.

During balance on the *right leg with closed eyes,* the majority of the participants obtained low grade scores as 35.29% (n=42) of participants obtained a grade score of 1 and 33.61% (n=40) obtained a grade score of 2. The median seconds to balance on the right leg with eyes closed were *2.00* seconds, with a Q_1-Q_3 range of 1.00-4.00 seconds.

Similar findings for the *left leg* was evident. The majority of the participants obtained a grade score of 2 (41.67%, n=50) while 29.17% (n=35) of the participants obtained a grade score of 1. The median seconds to balance on the left leg with eyes closed were *2.00* seconds, with a Q_1-Q_3 range of 2.00-4.00 seconds.

ii) Comparing the performance of SE groups on the measurable characteristics of the SB test

No significant difference was evident with regard to the measurable performance of participants balancing on the *right leg* with *eyes open* (*p*=0.52) and *closed* (*p*=0.87).

A significant grade difference on the measurable performance was found in participants balancing on the *left leg* with *eyes open* (*p*=0.03) and *closed* (*p*=0.04). During balance on the *left leg* with *eyes open*, differences can be observed during the allocation of grade score 5 and 2. Sixty-five percent (65.00%) (n=39) of participants from the HSES group, obtained a grade score of 5, compared to the 38.33% (n=23) of the LSES group. Only 3.33% (n=2) of participants from HSES obtained a grade score of 2, compared to 16.67% (n=10) participants from LSES, who received a grade score of 2.

During balance on the *left leg* with *eyes closed*, the majority of participants from LSES obtained lower grade scores when compared to participants from HSES. This can be seen during the allocation of grade score 2, were 51.67% (n=31) of participants from LSES obtained the grade score, compared to the 31.67% (n=19) participants from HSES. More participants from HSES (21.67%, n=13) obtained a grade score of 3 when compared to LSES (6.67%, n=4).

A significant time difference (p=0.03) was also evident between the two SE groups, balancing on the *left leg* with *eyes open*. Participants from HSES had a range of 8.00-24.50 seconds with a median of 12.50 seconds, with the LSES obtaining lower range and median scores. The LSES time range was 4.50-17.50 seconds with a median of 9.00 seconds.

4.3.10.2 Observable Characteristics of SB test

Table 4.25 illustrates the observable characteristics present in the group as a whole, as well as for both SE groups separately while performing the SB test. The content of the table is arranged from high to low prevalence for both SH and SNH parameters.

Table 4.25: Results of observable characteristics of SB test

			EYES OPEN						EYES CLOSED					
			Right leg			Left leg			Right leg			Left leg		
			(n)	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*
SH Parameter	Maintain arms in sides	Combined	97	80.83		102	85.00		98	81.67		87	72.50	
		HSES	49	81.67	0.82	52	86.67	0.61	50	83.33	0.64	46	76.67	0.31
		LSES	48	80.00		50	83.33		48	80.00		41	68.33	
SNH Parameters	Toe and ankle movement without displacing feet	Combined	107	89.17		109	90.83		103	85.83		105	87.50	
		HSES	53	88.33	0.77	56	93.33	0.34	49	81.67	0.19	49	81.67	0.05
		LSES	54	90.00		53	88.33		54	90.00		56	93.33	
	Body sway	Combined	88	73.33		79	65.83		68	56.67		78	65.00	
		HSES	42	70.00	0.41	35	58.33	0.08	27	45.00	0.01*	35	58.33	0.13
		LSES	46	76.67		44	73.33		41	68.33		43	71.67	
	Bracing against leg	Combined	60	50.00		68	56.67		45	37.50		61	50.83	
		HSES	36	60.00	0.03*	39	65.00	0.07	24	40.00	0.57	32	53.33	0.58
		LSES	24	40.00		29	48.33		21	35.00		29	48.33	
	Exaggerated movement of arms and trunk	Combined	42	35.00		45	37.50		72	60.00		78	65.00	
		HSES	23	38.33	0.44	23	38.33	0.85	35	58.33	0.71	38	63.33	0.70
		LSES	19	31.67		22	36.67		37	61.67		40	66.67	
	Anterior tilt of pelvis	Combined	53	44.17		54	45.00		49	40.83		52	43.33	
		HSES	29	48.33	0.36	29	48.33	0.46	23	38.33	0.58	23	38.33	0.27
		LSES	24	40.00		25	41.67		26	43.33		29	48.33	

*$p<0.05$

(Table 4.25: Results of observable characteristics of SB test – continued)

			EYES OPEN						EYES CLOSED					
			Right leg			Left leg			Right leg			Left leg		
			(n)	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*	*(n)*	*(%)*	*(p)*
SNH Parameters	Eyes or head not steady	Combined	54	45.00		56	46.67							
		HSES	25	41.67	0.46	25	41.67	0.27						
		LSES	29	48.33		31	51.67							
	Fixating body	Combined	23	19.17		24	20.00		59	49.17		59	49.17	
		HSES	12	20.00	0.82	14	23.33	0.36	33	55.00	0.20	32	53.33	0.36
		LSES	11	18.33		10	16.67		26	43.33		27	45.00	
	Shift supporting foot	Combined	27	22.50		20	16.67		24	20.00		25	20.83	
		HSES	18	30.00	0.05*	12	20.00	0.33	15	25.00	0.17	14	23.33	0.50
		LSES	9	15.00		8	13.33		9	15.00		11	18.33	
	Shoulder elevation	Combined	16	13.33		17	14.17		20	16.67		19	15.83	
		HSES	7	11.67	0.59	13	21.67	0.02*	9	15.00	0.62	10	16.67	0.80
		LSES	9	15.00		4	6.67		11	18.33		9	15.00	
	Asymmetry	Combined	15	12.50		11	9.17		2	1.67		4	3.33	
		HSES	8	13.33	0.78	4	6.67	0.34	0	0.00	0.50	2	3.33	1.00
		LSES	7	11.67		7	11.67		2	3.33		2	3.33	
	Associated reactions with the mouth	Combined	14	11.67		14	11.67		22	18.33		23	19.17	
		HSES	7	11.67	1.00	8	13.33	0.57	15	25.00	0.06	12	20.00	0.81
		LSES	7	11.67		6	10.00		7	11.67		11	18.33	
	Use vision to look at feet	Combined	9	7.50		7	5.83							
		HSES	2	3.33	0.16	2	3.33	0.44						
		LSES	7	11.67		5	8.33							
	Grabs onto clothing	Combined	1	0.83		6	5.00		3	2.50		3	2.50	
		HSES	1	1.67	1.00	3	5.00	1.00	2	3.33	1.00	1	1.67	0.56
		LSES	0	0.00		3	5.00		1	1.67		2	3.33	

*$p<0.05$

i) Describing the combined observable characteristics of the SB test

Combined scores are shaded in light grey in Table 4.25.

SH Parameters:

With *eyes open*, 80.83% (n=97) of the participants were able to *maintain their arms in the sides* while balancing on the *right leg*, with 85.00% (n=102) prevalence in the *left leg*.

With *eyes closed*, 81.67% (n=98) of the participants *maintained their arms* in the sides while balancing on the *right leg* and observed in 72.50% (n=87) of the participants performing the task with the *left leg*.

SNH Parameters:

With *eyes open*, *toe and ankle movement* was observed when performing with the right leg (89.17%, n=107) and when performing with the left leg (90.83%, n=109). *Body sway* was present in 73.33% (n=88) of the participants when balancing on the *right leg* and a 65.83% (n=79) prevalence while balancing on the *left leg*. Fifty percent (n=60) of participants *braced their leg* while balancing on the *right leg* and was also observed in 56.67% (n=68) when balancing on the *left leg.* All other SNH parameters were observed in 44.17% (n=53) or less of participants when analysing the combined results for balancing on one leg with eyes open (e.g., *anterior tilt of pelvis*).

With *eyes closed*, similar SNH parameters were frequently observed. Eighty-five point eight-three percent (85.83%) (n=103) of the participants had *toe and ankle movement* when balancing on the *right leg* and were even more present while balancing on the *left leg* (87.50%, n=105). *Body sway* was present in 56.67% (n=68) of the participants balancing on the *right leg* and present in 65.00% (n=78) balancing on the *left leg*. *Exaggerated movement of the arms and trunk* and *fixation of the body* were more prevalent when vision was occluded. *Exaggerated movement of the arms and trunk* was observed in 60.00% (n=72) of the participants balancing on the *right leg* and observed in 65.00% (n=78) of participants balancing on the *left leg* with *fixation* observed in 49.17% (n=59) of the participants when balancing on both right and left leg.

All other SNH parameters were observed in 43.33% (n=52) or less of participants when analysing the combined results for balancing on one leg with eyes closed (e.g. *anterior tilt of pelvis*).

ii) Comparing the performance of SE groups on the observable characteristics of the SB test

SH Parameter:

No significant difference was evident between the SE groups with regard to the SH parameter for SB test.

SNH Parameters:

Balancing on the *right leg with eyes open, bracing against the opposite leg* and *shift supporting foot* had significant differences (p=0.03 and p=0.05) between the SE groups. More participants from HSES *braced against the opposite leg* (60.00%, n=36) and *shifted the supporting foot* (30.00%, n=18), compared to LSES (40.00%, n=24 and 15.00%, n=9).

Balancing on the *left leg with eyes open, shoulder elevation* had a significant difference (p=0.02), as the parameter was present in 21.67% (n=13) of the participants from HSES compared to only 6.67% (n=4) prevalence in participants from LSES.

Balancing on the *right leg with eyes closed, body sway* had a significant difference (p=0.01), as the parameter was present more in participants from LSES (68.33%, n=41), compared to participants from HSES (45.00%, n=27).

No significant difference was found between the two SE groups for balancing on the *left leg with eyes closed*.

4.4 Summary

In Chapter 4, the results were presented in table format by means of percentages, and *p*-values. The researcher presented the performance of 120 participants on ten selected COs items with reference to the measurable and observable characteristics.

Descriptive observations were evident and could thus be described and quantified, for five-year-old children performing the ten selected COs items. The results indicated that several COs items' SH parameters were not always present and several SNH parameters were present in the five-year-olds' execution of the ten selected COs items. Furthermore, SE differences in test performance among the sample size (n=120) were compared and reported on. Overall the two SE groups performed similar on the subtests, with the exception of a few COs items.

In Chapter 5 the results will be discussed, interpreted and argued in accordance with related literature.

CHAPTER 5

Discussion of results

5.1 Introduction

In Chapter 4, the results of the study related to the performance of 120 five-year-old children from Bloemfontein, Mangaung Metro District, on ten selected Clinical Observations (COs) items were presented by means of tables. Chapter 5 will discuss, interpret and argue these results, in relation to relevant literature.

The discussion of the results will follow the same editorial sequence as in Chapter 4, as provided below:

- Discussion of the demographic information of the participants,
- Discussion of the 10 selected COs items with reference to:
  - Measurable Characteristics
    - Describing the grade score and numerical value with reference to the duration in seconds or number of repetitions in movement patterns,
    - Describing the difference(s) in performance of participants from low socio-economic status (LSES) and high socio-economic status (HSES) on the measurable characteristics, using *p-values.*
  - Observable Characteristics
    - Describing the observable characteristics present in the study population, categorised according to three groups, based on their prevalence (cf. 5.1 b),
    - Describing the difference(s) in performance of participants from LSES and HSES on the observable characteristics, using *p-values.*

With reference to the sequence stated above, the following section explains the approach followed in the discussion of the measurable, observable characteristics and socio-economic (SE) differences conversed in this chapter.

a) Clarifying the content of the *measurable characteristics*

The possible grade scores ranged from 1-5 as discussed in previous chapters (cf. 3.2.4.1; 4.1). Clinically, a grade score of 4 and 5 is viewed as adequate or typical performance (Cook et al., 2004 and Cook et al., 2016). It would, therefore, be expected that the majority of typically developing children would receive a score of 4 or 5 in the varous items of the COs. Findings relating to grade scores obtained will thus be discussed from this perspective.

Other measurable characteristics, such as the duration in seconds or number of repetitions in movement patterns will be discussed with reference to the median and inter-quartile ranges to contribute to a greater understanding of what can typically be expected of the five-year-old child when performing the 10 COs items included in this study.

b) Clarifying the content of the *observable characteristics*

The discussion of the *observable characteristics* will entail consideration of the prevalence of these characteristics in the study population. In order to enhance the clinical interpretation and usefulness of the results, the results were categorised as observable characteristics that were present *frequently*, *sometimes* or *seldom* according to the following prevalence criteria:

1. Frequently present (observed in 75.00%-100.00% of participants);
2. Sometimes present (observed in 25.00%-74.99% of participants);
3. Seldom present (observed in 0.00%-24.99% of participants).

Although similar descriptive studies were done by Harris (1981), Bowman and Katz (1984) and Gregory-Flock and Yerxa (1984), none of the studies categorised the parameters according to their occurrence and reported only on the prevalence of the observed parameters. No specific guideline could, therefore, be found in literature according to which results could be categorised to enhance the clinical usefulness of the data. However, the rationale to use 'should have' (SH) and 'should not have' (SNH) parameters, can be ascribed to the use of these parameters in the Sensory Integration and Praxis Test (SIPT) (Ayres, 1989, p. 35). Ayres (1989, pp. 35, 45) used the term SH parameters to describe "desirable characteristics" and SNH parameters to describe “non-favorable, atypical” characteristics when scoring the Design Copying subtest of the SIPT. The researcher decided to make use of similar terms in order to differentiate between “desirable” and “atypical” performance observed in the COs.

Consequently, the researcher decided on the three categories with the purpose of distinguishing the parameters that are expected to occur in the study population from those that are not expected.

In the SH parameters (i.e. those parameters that are thought to be expected during the performance of each item), the parameters that are observed *frequently* would be a reasonable expectation of the five-year-old child. However, those SH parameters that are *seldom* present, should not be expected of the five-year-old child, while those that are *sometimes* present would not necessarily be indicative of a problem if they are not present in the five-year-old child.

The SNH parameters that were *seldom* present in the study population would most likely be indicative of possible difficulty when observed in the five-year-old child as most typically developing five-year-old children in this study did not display these parameters. However, when SNH parameters occurred *frequently*, those SNH parameters are thought not to be indicative of dysfunction as they were found to be present frequently in a typically developing population. SNH parameters that occurred *sometimes* could or could not be an indication of difficulty and should always be interpreted with caution.

A summary of the observable characteristics categorised into the three groups, according to their SH and SNH parameters will firstly be portrayed, by means of tables. Thereafter, a discussion of the three categories will follow.

An overall discussion will be given for the items’ parameters in which performance with the right, left and both hands were observed, unless notable differences were present between left and right or between unilateral and bilateral execution, in which case the findings relating to left, right and both hands will be discussed separately. The researcher will range the percentages obtained for both measurable and observable characteristics and will not discuss each hand’s percentage separately.

c) Clarifying the content of the *SE differences*

Only significant (p<0.05) differences will be discussed and the same principle will be applied for discussing notable differences in items containing execution of the action with the right, left and both hands as described in the previous paragraph.

In the discussion of the results of the study, the researcher uses the term five-year-old children to refer to the study population of children aged five years six months to five years eleven months. Refer to Appendix I for the procedure of each test.

5.2 Demographic information of participants

The study population comprised of 120 typical children, aged five years six months to five years eleven months and enrolled in Grade R. As previously stated (cf. 3.2.2), the population was chosen due to, firstly their current phase of school enrolment as early identification of problem areas can assist in early intervention (Case-Smith, 2010, pp. 74-75) before entering formal schooling. The second reason is that pre-schoolers aged four to six years comprise up to 92.50% of the South African (SAn) occupational therapist (OTs) client population (Janse van Rensburg et al., 2017).

In order for the two groups to be comparable, an equal amount of gender and socio-economic status (SES) were included in the study.

The majority of the population were black (81.67%, n=98) and Sesotho speaking (71.66%, n=86). This correlates well with the racial distribution of Mangaung Metro district where the study was conducted (cf. 2.5.1), of which 77.80% of residents are black Africans (Statistics South Africa, 2011b, p. 10).

A similar number of participants were included from each six-moth age interval. None of the children withdrew from the study and 10.83% of the participants required further referral to health practitioners. The referrals included an in-depth occupational therapy (OT) evaluation for 10 of the participants, and 3 participants were referred to an optometrist. If the participants performed remarkably poorly on more than three items, the researcher indicated that an in-depth OT evaluation was recommended, and if problems with eye movements were observed, the researcher indicated a referral to an optometrist.

This was recorded on the parent feedback letter (cf. Appendix J), which also contained the researcher's contact details should the parents require any further information. The classroom educators assisted the researcher to remind the parents of the letters in the children's backpacks. None of the parents phoned the researcher.

5.3 Discussion of COs items

The results of the ten selected COs items according to the measurable and observable characteristics will now be discussed and interpreted according to relevant literature.

5.3.1 Diadokokinesis (DDK)

5.3.1.1 Measurable characteristics of DDK test

According to Table 4.2 (p. 87), the majority of the children obtained a grade score of 4 and 5 (71.67%-80.83%, n=86-97). This was obtained for the right, left and both hands. The study population performed adequately with the execution of the DDK test, unilaterally and bilaterally. The findings correlates with Dunn's (1981, p. 32) findings, as she also found five-year-old children perform similarly with the right and left hand on the DDK test. The results indicate that typical five-year-old children will be able to perform the action with both hands and the inability to do so can be an indication of difficulty, such as poor bilateral integration (SAISI, 2005, p. 62).

The median pronation-supination movements in 10 seconds were *12 complete* patterns with a first to third quartile (Q_1-Q_3) range of 10-13 pronation-supination movements. The performance is better than Dunn's findings (1981, p. 32), as she found five-year-old children can perform four complete forearm repetitions on the thighs. However, the findings are comparable to the findings of Wilson et al. (2000 in Bundy, 2002, p. 181) who found five-year-old children can perform nine and more repetitions in ten seconds.

5.3.1.2 SE differences on the measurable characteristics of the DDK test

Children from LSES performed significantly better than children from HSES with the performance for the left (p=0.05) and right hand (p=0.00) respectively. No difference was, however, noted for bilateral performance (p=0.63).

The major difference between the two groups seemed to lie in the allocation of a grade score of 5, which was allocated more frequently to the LSES group (40.00%-46.67%, n=24-28) than to the HSES group (18.33%-25.00%, n=11-15), and a grade score of 3 that was allocated more frequently to the HSES group (23.33%-30.00%, n=14-18) than to the LSES group (5.00%-18.33%, n=3-11).

Literature highlights the effect of SES on the physical environment (Case-Smith, 2010, pp. 58, 77) during childhood development, with the reality of occupational barriers and higher prevalence of difficulties in sensory integration (SI) faced by children from low SE households (Van Jaarsveld, 2010, p. 8). This leads to the initial assumption that children from the LSES would perform worse than their HSES, counterparts. However, this is not evidenced in the results of the DDK subtest of this study (cf. 6.3.3 a).

5.3.1.3 Observable characteristics of DDK test

Table 5.1 summarises the observable characteristics present in both groups, while performing the DDK test and categorised according to the prevalence criteria (cf. 5.1 b).

Table 5.1: Summary of observable characteristics of DDK test

	Frequently Present	Sometimes Present	Seldom Present
SH Parameters	• Starting position – supinated • Positioning of the thumb next to index finger • Rhythmical movements	• Isolated forearm movements	• Starting position - pronated
SNH Parameters		• Fixation of upper arm • Shoulder elevation • Use vision	• Incoordination • Sloppy movement • Extreme caution • Double tapping the hands • Associated reactions with the mouth • Slap hard on legs • Press elbows against body • Rigid body • Absence of supination • C-curved hands • Rolling forearms on legs • Associated reactions of the opposite hand • Unusual finger movement

i) <u>Frequently Present</u>

Table 4.3 indicates the majority (74.17%-78.33%, n=89-94) of the five-year-old study population started the DDK by first *supinating the forearm*. This can be expected as the first step in the administration of the test requires supination of the forearm (SAISI, 2005, p. 16) and the population was able to imitate the starting position.

Similar findings for *positioning of the thumb* next to index finger were evident. The majority (92.50%-96.67%, n=111-116) of the participant's *thumb were positioned next to the index finger*, which is the normal resting position of the hand in which the test is administered (SAISI, 2005, p. 16), which indicates the population were able to perform the DDK test with hands in resting position.

Rhythmical movements were seen in the majority (81.67%-87.50%, n=98-105) of the participants. The results correlates with literature from Bickerstaff (1976, p. 208), and SAISI (2005, p. 62), as irregular and jerky movements are associated with neuro-motor difficulties and dysfunctions, such as cerebellar dysfunction.

ii) <u>Sometimes Present</u>

Isolated forearm movements were present in a large part of the study population (59.17%-66.67%, n=71-80), more so than total arm rotation. Even though literature states total arm rotation may indicate "problems in performing selective movements" (SAISI, 2005, p. 62), the therapist should carefully interpret the observation, as a large group of the study population did not perform *isolated forearm movements*. This indicates total arm rotation can also occur without necessarily being indicative of difficulties. Yet, *isolated forearm movements* are more likely to occur in five-year-old children performing the DDK test, as seen in the study population.

Fixation of the upper arm, *shoulder elevation* and *vision* were also sometimes observed. *Fixation of the upper arm* was observed during the DDK test (33.33%-37.50%, n=40-45), with a slight increase in the prevalence of the parameter during the left hand (45.00%, n=54). The majority of the children (88.33%, n=106) were right dominant and it is, therefore, likely that more frequent fixation of the non-dominant hand indicates increased effort in performing coordinated movements with the left hand.

Literature states that fixation during the DDK test is indicative of problems in performing the movement (SAISI, 2005, p. 62). As described above, the therapist should be careful with the interpretation of the parameter as it was observed in a third to just under half of the study population.

Shoulder elevation was observed more often during performance of the left (31.67%, n=38) and both hands (35.00%, n=42), than with the right hand (24.17%, n=29). This might suggest that the study population required extra effort, proprioceptive feedback and/or extra stabilising of the upper arms by elevating the shoulders, as the demand of the action increased from dominant, non-dominant hand and both hands together (SAISI, 2005, pp. 62-63). A higher occurrence of *shoulder elevation* in the non-dominant hand versus the dominant hand is also similar to the findings related to *fixation of the upper arm* as discussed in the previous paragraph. Even though the parameter had a low frequency occurrence, the parameter was observed in the study population and *shoulder elevation* may still be observed as the child performs the action with the non-dominant hand and bilaterally without being a definite indication of possible difficulty.

The use of *vision* (34.17%-39.17%, n=41-47) was sometimes observed in the study population. Literature states visually monitoring an action might be due to poor proprioceptive processing (SAISI, 2005, p. 63). Even though the results indicate that only about a third of the population utilised *vision* in a compensatory way, the therapist must carefully interpret the use of *vision* during the DDK test as an indication of difficulty.

iii) Seldom Present

As expected, a starting position of *pronation* was seldom present (21.67%-25.83%, n=26-31), as supination is the first action during the administration of the test (SAISI, 2005, p. 16).

Incoordination (3.33%-6.67%, n=4-8), *sloppy movement* (2.50%-4.17%, n=3-5), movement with *extreme caution* (0.83%-3.33%, n=1-4) and *double tapping* the hands (left and bilateral; 22.50%, n=27) were seldom present in the typically developing study population. This was expected, as literature associates these parameters with neuro-motor difficulties and dysfunctions such as cerebellar dysfunction (Bickerstaff, 1976,

p. 208 and Touwen, 1979, p. 59) and/or abnormal tone (SAISI, 2005, p. 62). Similar to this study where double-tapping the hands was seen in less than a quarter of the children, Dunn (1981, p. 32) found that a break-down in children's performance before 10 seconds should be regarded "to be outside of normal limits".

Associated reactions with the mouth (4.17%-10.00%, n=5-12) and *opposite hand* (0.00%-7.50%, n=0-9) had a very low prevalence. Literature supports the findings of the results, as the presence of these two parameters may be an indication of an immature nervous system (SAISI, 2005, p. 62) and, therefore, should not be expected to be present in the typical five-year-old child.

The children in this study mostly did not *slap hard on their legs* (12.50%-16.67%, n=15-20), *press elbows against the body* (24.17%, n=29) nor did they display a *rigid body* (5.83%-13.33%, n=7-16), *absence of supination of forearms* (6.67%-13.33%, n=8-16), *c-curved hands* (12.50%-15.00%, n=15-18), *rolling forearms on legs* (6.67%-15.00%, n=8-18) and *unusual finger movement* (0.00%, n=0). All of these SNH parameters are associated with difficulty in performing the DDK test (SAISI, 2005, p. 62-62) and can, through activity analysis, be associated with poor proprioceptive processing, poor proximal stability and other SI (e.g. poor praxis) and neuro-motor (e.g. low muscle tone) difficulties. The findings of this study, therefore, suggest that the SNH parameters that seldom occurred in the study population should be carefully noted by a therapist when they do occur in a five-year-old child, as they may indicate possible difficulties and should be investigated further through more comprehensive assessment.

5.3.1.4 SE differences on the observable characteristics of the DDK test

Significant differences were present for three SNH parameters.

During execution of the DDK test with the left hand, children from HSES had significantly more *shoulder elevation* (p=0.05) and relied more on *vision* during execution with the left and both hands (p=0.03-0.04). Both of these parameters occurred *sometimes* in the total study population (cf. 5.3.1.3 ii).

Children from HSES, also had significantly more *associated reactions of the mouth* (p=0.03) compared to LSES. *Associated reactions* were *seldom* observed in the total study population (cf. 5.3.1.3 iii).

In conclusion, more frequent presence of three SNH parameters among children from HSES, correlates with earlier findings of lower grade scores obtained by children from HSES on the DDK test (cf. 5.3.1.2).

5.3.2 Thumb-Finger Touching (TFT)

5.3.2.1 Measurable characteristics of TFT test

The majority of the children obtained a grade score of 4 and 5 (51.67%-61.66%, n=62-74) for the right and left hand. Performance with the dominant and non-dominant hand was similar, which is congruent with descriptions in literature of TFT performance among children (Mutti et al., 1998, p. 60 and SAISI, 2005, p. 63). The results indicate that most five-year-old children in this study were able to execute the TFT test unilaterally, correlating with research done by Page-El and Grossman (1973) stating typical five-year-old children can perform the action (in Mutti et al., 1998, p. 60).

However, although more than half of the children in this study were able to perform TFT unilaterally (51.67%-61.66%, n=62-74 obtained grade scores of 4 or 5), there was still a large proportion of children who experienced difficulty in performing TFT unilaterally and who obtained grade scores of 3 and lower (38.34%-48.34%, n=46-58). This may provide some explanation of other studies that have found that the TFT test cannot be expected of children five years and younger (Dunn, 1981 and SAISI, 2005, p. 63). The findings of this study suggest that TFT may not be a good indicator of the development of abilities such as co-ordination and praxis in five-year-old children, which are typically assessed through TFT (SAISI, 2005, p. 63), as performance on this item by five-year-old children varied.

Furthermore, most of the children in this study were unable to perform the TFT test bilaterally (49.19%, n=59 obtained a grade score of 1 and 2) and with vision occluded (54.63%, n=65 obtained a grade score of 1 or 2).

Therefore, it seems as though bilateral execution of TFT is a skill that should not be expected of a five-year-old child, also supported by literature, stating the skill to perform the TFT increases between the ages of five and seven years (Denckla, 1973).

5.3.2.2 SE differences on the measurable characteristics of the TFT test

Children from HSES performed better on the TFT than children from LSES. This was evident for the left hand (p=0.00) as a grade score of 5 and 3 were obtained more frequently by the HSES compared to the LSES' grade scores of 3 and 2 (cf. 4.3.2.1 ii). Similar results were obtained for both hands (p=0.00) and vision occluded (p=0.00).

Even though it is not expected of the five-year-old child to perform the TFT with both hands and vision occluded, children from HSES obtained higher grade scores compared to LSES (cf. 4.3.2.1 ii). This finding may have clinical significance, as children from HSES are more likely to be able to perform the TFT test than children from LSES, as found in the study.

With the TFT test, SH parameters were more frequently present in the HSES group (cf. 5.3.2.4), correlating with the higher scores awarded to children from the HSES group than the LSES group, and provides some additional confirmation for the higher grade scores awarded to the HSES group.

The findings on the measurable characteristics of the TFT test are contrasting to the results of the measurable characteristics of the DDK test, where the LSES group performed better (cf. 5.3.1.2). However, the nature of the TFT test is different to the DDK test, in that TFT can be a learnt skill which is influenced by a child's age (Denckla, 1973, p. 638 and Denckla, 1974, p. 737), while DDK is a more basic movement pattern reliant on cerebellar function (Touwen, 1979 and Levine et al., 1980). Mutti et al. (1998, p. 60) found children aged three years may start to successfully carry out the action of the TFT, with a definite increase in the child's performance up to seven years, reaching a plateau between eight and ten years (Denckla, 1974, p. 737). In addition, the ability to perform the TFT also relies on fine-motor co-ordination (Mutti et al., 1998, p. 42). As children from low SE backgrounds have limited resources and inadequate facilities putting scholastic development at risk (Donald, Lazarus, & Lolwana , 2002, p. 207), it is possible that they are not exposed to fine motor activities as often, compared to their counterparts, which might explain the significant difference between the performance of the two SE groups.

5.3.2.3 Observable characteristics of TFT test

Table 5.2 summarises the observable characteristics present in both groups, while performing the TFT test and categorised according to the prevalence criteria.

Table 5.2: Summary of observable characteristic of TFT test

	Frequently Present	Sometimes Present	Seldom Present
SH Parameters	• Thumb opposition • Touching fingers with tip of thumbs • Isolated finger movements with vision	SH indicators sometimes present during unilateral performance: • Good timing • Correct sequence • Double tapping fifth finger	SH indicators seldom present during bilateral performance: • Good timing • Correct sequence • Double tapping fifth finger
SNH Parameters	• Reliance on visual input	• Press hard on fingers • Associated reactions with the opposite hand	• Start with finger other than index • Restart pattern • Reverse pattern • Restart same forward sequence • Lose sequence • Associated reactions with the mouth • Slide along fingers • First performs action with one hand then the other • Sloppy movement • Double tap each finger • Slow movements

i) <u>Frequently Present</u>

Thumb opposition (96.67%-100.00%, n=116-120), *touching fingers with tip of thumbs* (91.67%-97.50%, n=110-117) and *isolated finger movements with vision* (75.00%-87.50%, n=90-105) were frequently observed. Literature indicates that the "inability to form adequate circles with thumb and fingers is another indicator of poor muscle-directing capacity" (Mutti et al., 1998, p. 42). It would thus be expected that typically developing children with adequate muscle-directing capacity should be able to perform good *thumb opposition*, *touch the tips of their fingers* and use *isolated finger movements* as was the case in this study.

According to SAISI (2005, p. 63), visual monitoring of the TFT action can be an indication of poor proprioceptive awareness. At the same time, however, smooth execution of TFT is not expected of a five-year-old child (SAISI, 2005, p. 63) (cf.

5.3.2.1). Thus, since the vast majority of participants in this study *relied on visual input* to perform the action, compensatory use of *vision* in a five-year-old child during execution of the TFT should not be regarded as indicative of poor proprioceptive processing.

ii) Sometimes Present

The following indicators occurred sometimes during the performance of the TFT with the right and left hand: *good timing* (47.50%-58.33%, n=57-70), *correct sequence* (45.00%-47.50%, n=54-57) and *double tapping the fifth finger* (31.67%-36.67%, n=38-44). *Good timing* and *double tapping the fifth finger* were also sometimes present during bilateral performance (25.00%-26.67%, n=30-32). According to literature, difficulty in performing the *sequencing* and *double tapping the fifth finger* can be an indication of poor motor planning and sequencing (SAISI, 2005, p. 63). However, it seems as though *poor timing*, *sequencing* and not *double-tapping the fifth finger* should be interpreted with caution among five-year-old children as a large group of the study population did not present with *good timing*, *sequencing* or *double-tapping the fifth finger*.

Literature states, *pressing hard on fingers* is evidence for seeking additional proprioceptive input (SAISI, 2005, p. 63) and *associated reactions with the opposite hand*, while performing the action unilaterally, can be indicative of an immature nervous system (Mutti et al., 1998, p. 24 and SAISI, 2005, p. 63). Both parameters sometimes occurred in the study population (*press hard on fingers*; 27.50%-43.33%, n=33-52 and *associated reactions with the opposite hand* 40.00%-45.83%, n=48-55). However, this skill cannot be expected of the five-year-old child (SAISI, 2005, p. 63 and cf. 2.4.3 ii) and if the typical five-year-old child *presses hard on the fingers* and presents with *associated reactions of the opposite hand*, it should be interpreted with caution as a large group of the study population did not *press hard on their fingers* and had *associated reactions of the opposite hand*.

iii) Seldom Present

The following indicators seldom occurred during the performance of the TFT with both hands and vision occluded: *good timing* (20.83%, n=25), *correct sequence* (13.33%-24.17%, n=16-29) and *double tapping the fifth finger* (18.33%, n=22).

As these parameters seldom occurred in the study population's execution of the TFT test, it is not realistic to expect *good timing*, good *sequencing* and *double-tapping of the fifth finger* to be present in the five year age-group, during bilateral performance and when vision is occluded. The absence of the parameters in five-year-old children should, therefore, not be ascribed to poor sequencing or poor motor planning (SAISI, 2005, p. 63) as described in literature.

Start with finger other than index (20.83%-24.17%, n=25-29), *performs pattern in reverse* (3.33%-5.83%, n=4-7), *restart pattern* (7.50%-11.67%, n=9-14), *restarting same forward sequence* (18.33%-23.33%, n=22-28) and *lose sequence* (7.50%-14.17%, n=9-17), were seldom present. According to Mutti et al. (1998, p. 42), the inability to perform the action due to reversing the pattern or being unsure which fingers need to be activated, can indicate poor sequencing and ordering skills. Therefore, while TFT (particularly when performed bilaterally and with vision occluded) was demonstrated as not being a good indicator of function in the five-year-old population in this study, gross inability to perform the action as demonstrated by these SNH parameters could be indicative of poor sequencing and ordering skills.

Other parameters seldom observed were *associated reactions with the mouth* (7.50%-10.83%, n=9-13), *slide along fingers* (5.00%-9.17%, n=6-11), *first performs action with one hand then other* (15.83%, n=19), *sloppy movement* (0.83%-5.00%, n=1-6), *double tap each finger* (0.00%-4.17%, n=0-5) and *slow movement* (0.83%-4.17%, n=1-5). The findings are consistent with literature as *associated reactions of the mouth* are evidence of an immature nervous system and *sliding along the fingers* indicate additional tactile input (SAISI, 2005, p. 63). Even though the parameter, *first perform action with one hand then the other*, can indicate bilateral coordination difficulties, as previously stated, it is not expected of the five-year-old child to perform the TFT with both hands (cf. 5.3.2.1).

5.3.2.4 SE differences on the observable characteristics of the TFT test

SH parameters such as *double tapping the fifth finger* (p=0.00-0.01), *correct sequence* (p=0.00-0.02), *good timing* (p=0.04) and *isolated finger movements* (p=0.00-0.05) were observed more frequently among children from HSES (cf. 4.3.2.2 ii, p. 99).

The following SNH parameters were observed more frequently among children from LSES: *restarting same forward sequence* with the right hand (p=0.03), *not starting with index finger* with the left hand (p=0.02) and with vision occluded (p=0.01) and *performing with one hand then the other*, during bilateral hand use (p=0.00) and vision occluded (p=0.02). On the other hand, *associated reactions of the opposite hand* (p=0.01-0.04) was observed more frequently in children from HSES (cf. 4.3.2.2 ii, p. 99).

In conclusion, the TFT indicated significant differences in both SH and SNH parameters. A higher prevalence of SH parameters and lower prevalence of SNH parameters, among children from HSES, correlates with earlier findings of higher grade scores obtained by children from HSES on the TFT test (cf. 5.3.2.2).

5.3.3 Equilibrium Reactions (ER)

5.3.3.1 Measurable characteristics of ER test

According to Table 4.6 the majority of the children obtained a grade score of 4 and 5 in prone (83.33%, n=100) and four point kneel positions (90.00%, n=108). The prevalence for grade scores of 4 and 5 decreased during upright kneel (58.34%, n=70) and long sit (57.50%, n=69). In upright kneel position, the majority of the children obtained a grade score of 4 (41.67%, n=50) and in long sit, the majority of the children (32.50%, n=39) performed the action with slight deficiency and obtained a grade score of 3. The grade score specifications for obtaining a grade score 3 was the presence of 4 SNH parameters (cf. Appendix I 3). From the findings of the observable characteristics of ER (cf. 5.3.3.3), more SNH parameters were present during long sit and scored accordingly, even though assumed SNH parameters may not necessarily be indicative of a problem area in the five-year-old population. For example, one SNH parameter (*c-curve in the upper trunk*) had a high occurrence (cf. 5.3.3.3).

The researcher's decision to base the allocation of grade scores partly on the presence of SNH parameters might have influenced the measurable characteristics' results on the ER subtest, and the researcher would recommend that this be avoided in future studies. Thus, with the scoring criteria used in this study, ER in long sit reflects as slightly deficient, even though the study found more SNH parameters occurred during the performance of the long sit position. This change in interpretation of the SNH parameter based on the findings of the study, could possibly change the scoring allocation from a grade score of 3 to a grade score of 4 (cf. Appendix I 3).

Overall, the study population presented with adequate ER, correlating with literature that indicates ER develops between six and eighteen months (Fiorentino, 1973, pp. 38-44).

5.3.3.2 SE differences on the measurable characteristics of the ER test

In *prone*, a significant difference was evident (*p*=0.03) between the two SE groups, as a grade score of 5 was more often allocated to the HSES (78.33%, n=47) than the LSES (56.67% n=34). Even though more children from the HSES obtained higher grade scores, the findings have no significant clinical value as both SE groups performed adequately on the subtest.

A significant difference in the performance of SE groups in *long sit* (*p*=0.04) was also evident. Children from HSES performed better, as they obtained grade scores of 5 (38.33%, n=23) and 4 (25.00%, n=15) most often, compared to the LSES' grade scores of 3 (41.67%, n=25) and 4 (31.67%, n=19). Children from LSES performed the long sit position with slight deficiency, more so than children from HSES. As previously discussed (cf. 5.3.3.1), the administration of the scoring based on parameters might have influenced the grade score in long sit, as more parameters were observed. The findings, therefore, have no significant clinical value.

5.3.3.3 Observable characteristics of ER test

Table 5.3 summarises the observable characteristics present in both groups, while performing the ER test and categorised according to the prevalence criteria.

Table 5.3: Summary of observable characteristic of ER test

	Frequently Present	Sometimes Present	Seldom Present
PRONE POSITION			
SH Parameters	• Elongation of weight bearing side • Flexion of non-weight bearing side • Weight shift	• Fluid response	• Trunk rotation
SNH Parameters		• Widen base of support	• Lower centre of mass • Relies on protective extension • Rigid response • Lordosis and anterior tilt of pelvis • Holds onto tilt board • Fixate arms against body • Associated reactions with the mouth • C-curve in upper trunk • Arm abduction more and less than 45° • Press feet together • Grasp clothing
FOUR POINT KNEEL POSITION			
SH Parameters	• Elongation of weight bearing side • Flexion of non-weight bearing side • Weight shift • Trunk rotation	• Fluid response	
SNH Parameters		• Lower centre of mass • Lordosis and anterior tilt of pelvis	• Same as discussed in prone excluding centre of mass and lordosis • In addition widen base of support

(Table 5.3. Summary of observable characteristics present in ER test and categorised according to the prevalence criteria – continued)

	Frequently Present	Sometimes Present	Seldom Present
UPRIGHT KNEEL POSITION			
SH Parameters	• Elongation of weight bearing side • Flexion of non-weight bearing side • Weight shift • Trunk rotation	• Fluid response	
SNH Parameters	• Lower centre of mass	• Lordosis and anterior tilt of pelvis • Arm abduction less than 45° • Fixating arms against body	• Widen base of support • Relies on protective extension • Rigid response • Holds onto tilt board • Associated reactions with the mouth • C-curve in upper trunk • Arm abduction more than 45° • Press feet together • Grasp clothing
LONG SIT POSITION			
SH Parameters	• Elongation of weight bearing side • Flexion of non-weight bearing side • Weight shift	• Fluid response	• Trunk rotation
SNH Parameters		• Lower centre of mass • Widen base of support • Relies on protective extension • C-curve in upper trunk	• Rigid response • Lordosis and anterior tilt of pelvis • Arm abduction more and less than 45° • Holds onto tilt board • Fixate arms against body • Associated reactions with the mouth • Press feet together • Grasp clothing

i) Frequently Present

SH Parameters frequently observed in all four testing positions were *elongation of weight bearing side* (92.50%-100.00%, n=111-120), *flexion of non-weight bearing side* (85.83%-100.00%, n=103-120) and *weight shift* (85.83%-95.00%, n=103-114).

Trunk rotation was frequently present in four point kneel and upright kneel positions (82.50%-91.67%, n=99-110). The findings correlate with literature as inadequate ER entails the inability to rotate body around the longitudinal axis (SAISI, 2005, p. 67) and inability to weight shift (Ayres 1972 in SAISI, 2005, p. 67). Dunn (1981, p. 41) also states trunk changes should be present in typical ER. It is thus a realistic expectation that typical five-year-old children, as shown in the study, to present with *elongation of weight bearing side*, *flexion of non-weight bearing side* and *weight shift* in all four positions with *trunk rotation* present in four point kneel and upright kneel positions while performing ER.

With only one exception, none of the SNH parameters occurred frequently in this study population. *Lower centre of mass* was frequently observed (84.17%, n=101) in the upright kneel position. Literature states an upright position, among others, can challenge balance and the position could "have the effect of modifying the location of the centre of mass" (O'Brien & Williams, 2010, p. 257). During the upright kneel position, the children's base of support is the smallest of all four positions and an element of height is added, components that increases the demand on the balance system (O'Brien & Williams, 2010, p. 257). It is, therefore, possible that the study population's balance was more challenged in the upright position as found in literature, and as a result, the study population tended to *lower their centre of mass* as it is easier for children to maintain balance when the centre of mass is closer to the ground (O'Brien & Williams, 2010, p. 257). The presence of the parameter will, therefore, not necessarily be an indication of problematic compensatory action and can be present in the typical five-year-old child, as the parameter was frequently observed in the study population.

ii) Sometimes Present

A *fluid response* was sometimes observed in the children (25.00%-42.50%, n=30-51). It can consequently be expected that the typical five-year-old's ER will not be as fluid and can be supported by Dunn's (1981, p. 42) results as she states "…on-going development of equilibrium response is still a primary consideration when observing children in this age group".

Lower centre of mass was sometimes observed in the four point kneel and long sit positions (28.33%-40.83%, n=34-49). As previously described (cf. 5.3.3.3 i), the prevalence of the parameter will not necessarily be due to the child compensating for inadequate ER. However, the therapist should carefully interpret the observation, as a large group of the study population did not *lower their centre of mass* during the four point kneel and long sit positions.

Widen base of support was more observed in prone (44.17%, n=53) and long sit (52.50%, n=63) positions. Literature states that demands are placed on the balance system when the internal base of support changes (O'Brien & Williams, 2010, p. 257), placing less demand on the balance system when the base of support is widened. The parameter is also seen as a method to add more stability (SAISI, 2005, p. 25). The study population sometimes *widen their base of support* in prone and long sit and its presence would not necessarily be indicative of a problem.

Relies on protective extension (41.67%, n=50) and *c-curve in the upper trunk* (70.00%, n=84) were observed in long sit. In her study, Dunn (1981, p. 42) found that protective extension in upright kneel and standing positions was easily elicited in five-year-old children. Even though the position in which protective extension was elicited in the study population differs from the positions found in Dunn's (1981) study, she concluded that protective extension was still found to be "within normal range" for five-year-old children (Dunn, 1981, p. 42). *Relies on protective extension* and *presenting with a c-curved back* can still be present in the typical five-year-old child as found in the study.

Lordosis and anterior tilt of pelvis (36.67%-72.50%, n=44-87) (seen in both four point kneel and upright kneel positions), *arm abduction less than 45°* (55.00%, n=66) and *fixating arms against body* (27.50%, n=33) were the only parameters observed sometimes in upright kneel position. As previously described (cf. 5.3.3.3 i, p. 170), the nature of the upright kneel position can place an increased demand on the balance system and in addition, the upright kneel position was the only position where the arms are freely positioned next to the child's body. It is possible that this study population needed more control and used their arms to provide added stability. According to Fiorentino (1973, p. 43), one of the parameters for typical ER is abducting the arm on the raised side, which was indeed observed in many participants in this study. Even though Fiorentino's method of testing differed to the method used in this study, as Fiorentino only used an equilibrium board in the supine and prone position, the findings of both studies suggest that abduction of the arms are not problematic when observed in a five-year-old child. While *lordosis* and *anterior tilt of pelvis*, *arm abduction* and *fixating arms* were sometimes observed in the upright kneel position, it was seldom observed in other testing positions (cf. Table 5.3). The upright kneel position would, therefore, be the only position in which therapists could expect to see these three SNH parameters without it being indicative of possible difficulty in this age group.

iii) Seldom Present

Trunk rotation in prone and long sit was seldom observed (15.83%-20.83%, n=19-25). As previously stated (cf. 5.3.3.3 i, p. 170), the presence of trunk rotation is expected in typical ER. However, *trunk rotation* cannot really be performed in the prone position since trunk rotation is hampered by the presence of the equilibrium board in the plane of movement in which rotation is expected to occur. It is, therefore, not surprising that most children did not employ *trunk rotation* in the prone position. In the long sit position, on the other hand, *trunk rotation* could occur freely, but the children in this study population made use of other actions (such as lateral flexion and weight shift). Therefore, the absence of *trunk rotation* in the five-year-old child in the prone and long-sit positions is not necessarily an indication of inadequate ER.

Widen base of support in four point kneel (4.17%, n=5) and upright kneel (12.50%, n=15) positions were seldom observed in the study population. According to literature, *widen base of support* can be an indication of the need to compensate for inadequate ER through seeking added stability (SAISI, 2005, p. 25) and/or may be indicative of the child's method to place less demand on the balance system (O'Brien & Williams, 2010, p. 257). The absence of the parameter can be expected in the typical five-year-old's response during a four point kneel and upright kneel position, but its presence can be indicative of a problem area.

Rely on protective extension during prone, four-point kneel and upright kneel (0.83%-23.33%, n=1-28) positions were seldom present. The typical five-year-old child will use ER to maintain balance in these positions without relying solely on *protective extension*.

Rigid response (10.83%-24.00%, n=13-24), *holds onto tilt board* (3.33%-13.33%, n=4-16), *fixate arms against body* (0.00%-16.67%, n=0-20), *associated reactions with the* *mouth* (0.00%-11.67%, n=0-14), *c-curve in upper trunk* (0.00%-4.17%, n=0-5), *arm abduction more than 45°* (0.00%-8.33%, n=0-10), *press feet together* (1.67%-9.17%, n=2-11) and *grasp clothing* (0.00%-4.17%, n=0-5) were seldom present. These parameters can be expected not to be present in the typical five-year-old child, and their presence can, through activity analysis, be associated with poor proprioceptive processing, poor proximal stability and an immature nervous system (SAISI, 2005, p. 62).

5.3.3.4 SE differences on the observable characteristics of the ER test

In *prone,* one SH parameter: *flexion of non-weight bearing* side (p=0.00) was more observed in HSES (95.00%, n=57), compared to LSES (76.67%, n=46). The difference, however, does not seem to be clinically significant as the parameter was still frequently present in both groups, thus it is realistic to expect the parameter to be present in five-year-old children from any SES.

In *prone*, SNH parameters, *rigid response* (p=0.04) and *widen the base of support* (p=0.02) showed significant differences, as rigid response was more observed in LSES (16.67%, n=10) compared to HSES (5.00%, n=3). Still, in both groups, a *rigid response* was seldom present and is thus not expected in most typically developing five-year-old children. The difference between HSES and LSES groups, therefore, does not present any clinical significance, and as found from the results, it can be expected not to be present in the typical five-year-old child. The opposite was found for *widen base of support*. More children from HSES (55.00%, n=33) *widen their base of support* compared to LSES (33.33%, n=20). *Widen base of support* was found to be sometimes present in both groups of the study population, and can, therefore, be expected to be sometimes present in the five-year-old child from any SES.

In *upright kneel*, SNH parameter: *relied on protective extension* (p=0.02) had a significant difference, as it was more observed in children from HSES (26.67%, n=16), compared to LSES (10.00%, n=6). These differences, however, do not seem to be of clinical significance as the *relied on protective extension* parameter was seldom present in typically developing children in this study.

In conclusion, the differences found on the observable characteristics of the ER test have no significant clinical value as differences cannot be interpreted in isolation.

5.3.4 Prone Extension Posture (PEP)

5.3.4.1 Measurable characteristics of PEP test

According to Dunn (1981, p. 25), it is reasonable to expect the five-year-old child to perform the PEP with arms only. However, in this study, more five-year-old children were able to perform the full PEP compared to the PEP arms only (cf. Table 4.8). A study done by Longo-Kimber (1984) supports the results, as the study also found the five-year-old population to be able to perform a good PEP, extending both arms and legs. It is, therefore, a realistic expectation that more typical five-year-old children will perform the full PEP, however, adequate performance of PEP with arms only is also expected for this age group.

The median duration for the full PEP was 18 seconds, with a Q_1-Q_3 range of 13-24 seconds. The results do not support the mean duration of 54.40 seconds for the PEP in five-year-old children as was found by Longo-Kimber (1984, p. 129). However, the findings are consistent with research done by Ayres (1973, p. 100), stating that it can be expected of children under six years to perform the PEP for less than 20-30 seconds.

The median duration for PEP arms only was 27 seconds with a Q_1-Q_3 range of 16-45 seconds. The results indicate that children performed better on this test compared to research done by Dunn (1981, p. 25), as she found the age group can maintain the arms only posture for 15-20 seconds.

The less common observed PEP was with bent legs of 90°, and the children were able to maintain the bent legs position for a median of 15 seconds, with a Q_1-Q_3 range of 13-19 seconds. This is similar in duration to the full PEP. If five-year-old children are unable to assume the full PEP with extended legs, it may be more appropriate to ask them to assume the arms only position and assess the duration that they are able to maintain during the arms only position.

5.3.4.2 SE differences on the measurable characteristics of the PEP test

No significant differences were evident with the allocation of the grade scores and duration in seconds for the two SE groups. It can, therefore, be expected that typically developing five-year-old children from any SES would perform similarly on the measurable characteristics of the PEP, as found in the study.

5.3.4.3 Observable characteristics of PEP test

Table 5.4 summarises the observable characteristics present in both groups, while performing the PEP test and categorised according to the prevalence criteria.

Table 5.4: Summary of observable characteristic of PEP test

	Frequently Present	Sometimes Present	Seldom Present
SH Parameters	• Elbows in line or behind shoulders • Head held steady • Arch in upper trunk	• Head vertical 45° and more • Knees bent less than 45° • Thighs off mat from mid-thigh distally • Lift limbs simultaneously	
SNH Parameters		• Shoulder elevation • Fixation of body • Unable to lift knees off the ground • Thighs barely off mat • Head raised less than 45° • Flexed knees (between 50°-90°) • Assumes posture segmented (upper limbs first)	• Definite flexed knees • Back appears flat or minimally arched • Assumes posture segmented (lower limbs first) • Elbows forward of shoulders • Excessive effort required • Rocking body • Unable to count aloud • Stabilising legs placing one foot over the other • Associated reactions with the mouth • Asymmetry

i) <u>Frequently Present</u>

The SH parameters frequently observed in PEP were *elbows in line or behind shoulders* (86.66%, n=104), *head held steady* (79.17%, n=95) and *arch in upper trunk* (76.67%, n=92). Although descriptive literature is available on the PEP, the studies did not include the five-year-old population (Harris, 1981 and Bowman & Katz, 1984).

The studies that did include this age group, did not elaborate on the performance of the upper trunk (Gregory-Flock & Yerxa, 1984 and Longo-Kimber, 1984). However, Bowman and Katz (1984, p. 373) did find the majority of six-year-old children (93.90%) presented with an *arched back* and *elbows behind or in line of shoulders*. The typically developing five-year-old child would, therefore, be able to position *elbows in line or behind of shoulders*, *keep a steady head* and present with an *arch in the upper trunk*, as most of the five-year-old study population presented with these parameters.

None of the SNH parameters obtained a prevalence of 75.00% and more. This supports the hypothesis that none of the PEP subtests' SNH parameters should be present in five-year-old children.

ii) <u>Sometimes Present</u>

Head vertical, 45° and more (70.00%, n=84), *knees bent less than 45°* (39.16%, n=47), *thighs off mat from mid-thigh distally* (32.50%, n=39) and *lift limbs simultaneously* (31.67%, n=38) were sometimes observed. Similar findings were found by Gregory-Flock and Yerxa (1984, p. 193) for knees and thighs. The authors found 40.00% of the five-year-old population presented with slightly bent knees (less than 45°) and 35.00% were able to clearly lift their thighs off the mat. They did, however, find 60.00% of the children were able to lift their limbs simultaneously, different from the results found in this study.

The results for *lifting thighs off mat* and *barely off mat* were very similar (cf. Table 4.9), with no clear prevalence for the one or the other. It is a realistic expectation that both can occur in five-year-old children. The therapist should, therefore, be careful with the interpretation of the parameters as the results found the distance of the thighs cannot be the most important indicator for a good PEP, as also described in literature (Harris, 1981, p. 69).

Shoulder elevation (68.33%, n=82) and *fixation of body* (50.00%, n=60) were sometimes observed in the children. Both these parameters might be suggestive of the amount of effort that the execution of the PEP requires of the five-year-old child.

Shoulder elevation and *fixation of the body* sometimes occurred, but both in at least half of the study population. The presence of these SNH parameters are thus not considered indicative of dysfunction in the five-year-old population.

Unable to lift knees off the ground (35.83%, n=43), *thighs barely off mat* (31.67%, n=38), *head raised less than 45°* (30.00%, n=36), *flexed knees* (between 50°-90°) (25.00%, n=30) and *assumes posture segmented* (upper limbs first) (25.00%, n=30) occurred sometimes, in less than half of the study population. In the study of Gregory-Flock and Yerxa (1984, p. 193) conducted among five-year-old children, only 5.00% were unable to lift their knees off the ground, but 55.00% barely lifted their thighs off the mat. Bowman and Katz (1984, p. 373) found none of their six-year-old study population had poor neck extension, corresponding to the results in this study indicating a low occurrence of neck extension less than 45° in the five-year-old population. In the study of Gregory-Flock and Yerxa (1984, p. 193), the majority of the five-year-old children had knee flexion of 55° and more, different from the results found in this study. *Knee flexion more than 50°* was seldom present in the study population. This can, however, be influenced by the fact that the entire study population did not only take in one position as found in the study of Gregory-Flock and Yerxa (1984).

iii) <u>Seldom Present</u>

None of the SH parameters were seldom observed. There are thus no hypothesised SH parameters that are not expected to be present in the five-year-old child.

Back appears flat or minimally arched (23.33%, n=28), *assumes posture segmented* (lower limbs first) (7.50%, n=4), *elbows forward of shoulders* (13.33%, n=16) and *excessive effort required* to maintain posture (20.00%, n=24) were seldom present in the typical five-year-old child performing the PEP in this study. The parameter *assumes posture segmented* that was seldom present in the study population is supported by the study of Gregory-Flock and Yerxa (1984), who also found less children assumed the posture segmented. *Effort required* to maintain the posture was, however, more observed in the study of Gregory-Flock and Yerxa (1984) (45.00%), compared to the 20.00% found in this study.

Rocking body (22.50%, n=27), *unable to count aloud* (19.17%, n=23), *stabilising legs placing one foot over the other* (11.67%, n=14), *associated reactions with the mouth* (5.00%, n=6) and *asymmetry* (3.33%, n=4) were seldomly observed in the study population. According to literature, as age increases, the child exhibits less facial expressions, body sway and inability to count aloud, suggesting developmental changes occur between six and eight years of age (Bowman & Katz, 1984, p. 374). However, the results of this study found these parameters seldom occur in children aged five years and it is a realistic expectation that these parameters should not be present in the typical five-year-old child. The low occurrence of *associated reactions* and *asymmetry* in the typical child are also supported by literature, as it is stated that the prevalence of these parameters can respectively be indicative of an immature nervous system or inadequate cerebral hemisphere functioning (SAISI, 2005, pp. 62, 68).

5.3.4.4 SE differences on the observable characteristics of the PEP test

One SH parameter, *lift limbs simultaneously* (p=0.05) showed a significant difference between the SE groups. The parameter was more observed in children from HSES (40.00%, n=24) compared to those from LSES (23.33%, n=14). *Lift limbs simultaneously* were found to be sometimes present in both groups of the study population. However, analysis of separate SE groups indicates that *lift limbs simultaneously* was seldom present in the LSES group and sometimes present in the HSES group. It is difficult to interpret such an isolated observation, and differences in SH and SNH parameters will be considered as a whole (cf. 5.3.4.3) in an effort to make sense of patterns or clusters, should these occur.

Two SNH parameters showed significant differences between SE groups, namely *shoulder elevation* (p=0.01) and *inability to count aloud* (p=0.01). *Shoulder elevation* was more observed in LSES (80.00%, n=48) compared to HSES (56.67%, n=34). *Shoulder elevation* was categorised to be sometimes present in the five-year-old study population as a whole (cf. 5.3.4.3 ii). However, analysis of separate SE groups indicates that *shoulder elevation* was frequently present in the LSES group and sometimes present in the HSES group. As described above, parameters should not be interpreted in isolation.

With regard to the parameter, *inability to count aloud*, it was also observed more frequently in the LSES group (28.33%, n=17) compared to the HSES group (10.00%, n=6). While an *inability to count aloud* is often associated with excessive effort (SAISI, 2005, p. 29), the researcher cannot make the assumption that the inability of some children in this study to *count aloud* was only due to *excessive effort*, as the prevalence for the two parameters differed (cf. Table 4.9). More children from the LSES were *unable to count aloud* compared to the *effort* it took to maintain the posture (20.00%, n=12). It is, therefore, possible that some children from LSES were unfamiliar or uncertain how to count and, therefore, just kept quiet. This observation should be interpreted with caution in settings where children have not yet mastered the ability to *count aloud*.

In conclusion, the differences found in the PEP test, are isolated occurrences that have no clinical significance. However, the inability of children from LSES to count aloud should be interpreted with caution in settings where children have not yet mastered the skill to count aloud.

5.3.5 Tonic Neck Reflexes: Asymmetrical Tonic Neck Reflex (ATNR), Reflex Inhibiting Posture (RIP) & Symmetrical Tonic Neck Reflex (STNR)

5.3.5.1 ATNR

5.3.5.1.1 Measurable characteristics of ATNR test

According to Table 4.10, the majority of the children (88.33%, n=106) obtained a grade score of 1. In the current COs (SAISI, 2005, p. 32) the grade score allocation is based on the degree of elbow flexion, and a grade score of 1 indicates elbow flexion more than 25°. This reference was also used in the study, where a grade score of 1 was allocated when the degree of elbow flexion was more than 45° (cf. Appendix I 5.1). The administration of the ATNR test required to not only allocate a grade score but also record the degree of elbow flexion present for each side (cf. Appendix I 5.1 Picture 8), measuring each child's degree of elbow flexion.

From the results, it was evident that the majority of the study population presented with elbow flexion more than 45°.

The median degree of elbow flexion obtained by the right side was 71.50°, with a Q_1-Q_3 range of 54.00° - 83.00°. For the left side, elbow flexion of a median of 74.00° with a Q_1-Q_3 range of 57.00° - 82.50° was present in the typical five-year-old population in this study. The findings are not consistent with the current available literature on the normative data of the ATNR test.

Parmenter (1983, p. 463) found elbow flexion of 31° - 60° can be expected in first graders, DeGangi, Berk and Larsen (1980, p. 457) found three to five-year-old children presented with 30°-60° elbow flexion with Zemke (1984 in Zemke, 1985, p. 178) reporting elbow flexion of 32° to be expected of the five-year-old child. However, Parmenter (1975, p. 468) found first and third graders did not frequently present with elbow flexion beyond 30° and should this occur; it is indicative of a possible inhibited reflex.

When scoring and interpreting the ATNR on the guidelines using the degree of elbow flexion as an indicator of the presence of the reflexes (SAISI, 2005, p. 72), the majority of the study population's ATNR were thus not integrated. This is contrary to suggestions made in literature that the reflex should be integrated at 6 months of age (Fiorentino, 1973, p. 13). A study done in England on four and five-year-old children also found signs of un-integrated primitive reflexes and attributed it to a lack of physical stimulation (Clark, 2012). Van Jaarsveld (2010) also found a high prevalence of primitive reflexes present in SAn children aged three to five years, from LSES. It is possible that the ATNR is not integrated in the study population and this might have a negative effect on their postural control (Shumway-Cook & Woollacott, 2012, p. 197).

Dunn (1981, p. 29), however, also found in her study, that five-year-old children presented with a great deal of elbow flexion (mean 55°). Nonetheless, she concluded that her findings are not reliable statistics to use when assessing a five-year-old child as she states: "When approaching this amount of flexion, the arm isn't very stable for support, which may be a false limit to rely on" (Dunn, 1981, p. 29). In addition, she was unable to determine why the 55° elbow flexion was only present in the right arm. She suggested one should rather observe if the five-year-old child is able to perform the reflex inhibiting posture (RIP) (cf. 5.3.5.2), as it can be more helpful in identifying the presence of the reflex. Her suggestion assessing ATNR in the five-year-old child is also included in the currently used COs (SAISI, 2005, p. 72).

From these findings, it seems as though the ATNR test could be very sensitive (that is, the ability to identify people who present with a specific condition, in this instance, children who present with an un-integrated ATNR) (Hellebrandt et al. 1962 in Parr, Routh, Byrd, & McMillan, 1974, p. 330), but that there is reason to question the specificity (that is, the ability of a test to correctly exclude people without the condition) for reasons as mentioned above. The researcher thus concludes that it is necessary to consider other indicators of the presence of the ATNR in children, such as the RIP (cf. 5.3.5.2) and the Schilder's Arm Extension (SAE) test (cf. 5.3.7.3 i,) before drawing definitive conclusions.

5.3.5.1.2 SE differences on the measurable characteristics of the ATNR test

No significant differences were evident in the grade score (p=0.87) and degree of elbow flexion (p=0.97), leading to the conclusion that children from both SE groups performed similarly on the ATNR test.

5.3.5.1.3 Observable characteristics of ATNR test

Table 5.5 summarises the observable characteristics present in both groups while performing the ATNR test and categorised according to the prevalence criteria.

Table 5.5: Summary of observable characteristic of ATNR test

	Frequently Present	Sometimes Present	Seldom Present
SH Parameters			• Elbow flexion less than 25° • No changes in joint position
SNH Parameters	• Elbow flexion of contralateral arm	• Tends to lock elbows • Resistance to head turn	

i) <u>Frequently Present</u>

None of the SH parameters obtained a prevalence of 75.00% and more, opposing the hypothesis that the ATNR subtests' SH parameters should frequently be present.

Elbow flexion of the contralateral arm (91.67%-92.50%, n=110-111) was frequently present in the study population. As described in 5.3.5.1.1, the majority of the study population's ATNR should be seen as not integrated, if it is only based on the degree of elbow flexion.

However, Parr et al. (1974, p. 333) mentioned elbow flexion of the contralateral arm could possibly be due to a "bio-mechanical reaction," pulling the arm into flexion when the head is turned too far. In the present study, the researcher made sure that the measurement is taken when the head is rotated only 90° and not during passive movement, to eliminate the possibility of a "bio-mechanical reaction."

However, Dunn (1981, p. 29) mentioned head rotation of 90° can exert enough stress on the five-year-old child to trigger rotation of the body and Ayres (1973, p. 107) also found the ATNR can more easily be elicited in typical children under eight years of age, due to immature postural mechanisms.

Taking into consideration the discrepancies in literature regarding when the degree of elbow flexion is an indication of an abnormality (cf. 5.3.5.1.1), the influence of stress, immature postural mechanisms in younger children and the great deal of *contralateral elbow flexion* observed in the majority of the typical five-year-old study population, the researcher supports Dunn's (1981, p. 29) and Ayres's (1973, pp. 102-103) suggestion that therapists should rely on the RIP as well as the SAE (cf. 5.3.7.3 i) test to draw definitive conclusions regarding the presence of the ATNR and should not rely only on the degree of elbow flexion present.

ii) <u>Sometimes Present</u>

None of the SH parameters obtained a prevalence between 25.00%-74.99%.

Tends to lock elbows (63.33%-64.17%, n=76-77) and *resistance to head turn* (45.83%, n=55) was sometimes observed in the study population.

According to literature, the prevalence of *resistance to head turn* can indicate a lack of integration as the child is attempting to avoid the disorganising influence of the reflex (Ayres, 1973, p. 102).

It is possible that the study population who gave resistance to head movement wanted to avoid the disorganising influence of a possible unintegrated ATNR. However, the parameter drastically decreased during the RIP (cf. 5.3.5.2.3 iii). Therefore, the therapist should observe the child's RIP before making a conclusion about the ATNR, and not rely on only one parameter.

iii) Seldom Present

Elbow flexion present, less than 25° (5.00%-6.67%, n=6-8) and *no changes in joint position* (0.00%, n=0) were seldom present in the typical five-year-old child. When interpreting the prevalence of the parameter according to the normative guidelines described in literature (cf. 5.3.5.1.1), only these children's ATNR reflex would be considered as integrated.

However, Parr et al. (1974) concluded that in all the research participants in their study aged between three and nine years, the ATNR was elicited, even though the degree of elbow flexion present did not exceed 20°. This highlights the discrepancies in literature regarding when the degree of elbow flexion is an indication of an abnormality (Parmenter, 1975; DeGangi et al., 1980; Parmenter, 1983; Zemke 1984 in Zemke, 1985 and SAISI, 2005).

The current study showed *elbow flexion less than 25°* was seldom present in the typically developing five-year-old population; i.e., most five-year-old children presented with *more than 25° of elbow flexion*. Consequently, it would seem that the assessment of ATNR as performed in this study is probably not a good indication of an inhibited ATNR in five-year-old children as also suggested by Dunn (1981). The researcher will further discuss and reason on the ATNR in 5.3.5.2 and 5.3.7.3, considering the absence or presence of the reflex in the study population. The discussion of the ATNR will thus continue in the relevant sections of Chapter 5.

None of the SNH parameters were seldom observed in the five-year-old children.

5.3.5.1.4 SE differences on the observable characteristics of the ATNR test

No significant differences were evident in the parameters, making the conclusion that children from both SE groups performed similarly on the ATNR test.

5.3.5.2 RIP

5.3.5.2.1 Measurable characteristics of RIP test

According to Table 4.12, more than half of the children obtained a grade score of 4 and 5 (62.50%-68.33%, n=75-82). This indicates that the majority of the children were able to assume the posture longer than 4 seconds with more than 3 SH parameters present. A grade score of 1 was seldom obtained (6.67%-7.50%, n=8-9) indicating the children that were unable to assume the posture. Dunn's (1981, p. 30) findings correlate with the results, as she found the majority (56.00%) of five-year-old children were able to assume the posture without difficulty and only 6.00% were unable to perform the RIP. When using Dunn's (1981, p. 29) suggestion to observe both the degree of elbow flexion in four-point kneel as well as the ability to maintain the RIP as previously stated (cf. 5.3.5.1.3 i), the data suggests that the majority of the five-year-old study population did present with an integrated ATNR. This seems more likely when the theoretical developmental sequence of reflex integration (Fiorentino, 1973, p. 13) is considered, than an un-integrated ATNR in more than 90% of the study population as suggested when only looking at the degree of elbow flexion in four-point kneel (cf. 5.3.5.1.1).

The median duration for maintaining the RIP position was 6-7 seconds with a Q_1-Q_3 range of 4-13 seconds. It is, therefore, a realistic expectation that the majority of the five-year-old children will be able to assume the posture for 4-13 seconds without difficulty. An inability to maintain the RIP position among this age group was seldom present and its presence can possibly be an indication of a lack of integration of the ATNR.

5.3.5.2.2 SE differences on the measurable characteristics of the RIP test

No significant differences in the performance of the two SE groups on the RIP (cf. Table 4.12) were evident in this study population. It would thus be expected that typically developing five-year-old children from HSES and LSES groups, would perform similarly on the measurable characteristics of the RIP.

5.3.5.2.3 Observable characteristics of RIP test

Table 5.6 summarises the observable characteristics present in both groups while performing the RIP test and are categorised according to the prevalence criteria.

Table 5.6: Summary of observable characteristic of RIP test

	Frequently Present	Sometimes Present	Seldom Present
SH Parameters		• Assume posture fluently • Head held steady • Straight leg • Straight back • Elbow flexion less than 25° • Head in line with back • Able to independently keep chin against shoulder	• Leg and knee in line with hip
SNH Parameters	• Body sway	• Elbow flexion more than 25°	• Associated reactions with the mouth • Open shoulder and turn body • Excessive lordosis • Tends to lock elbows • Retracts chin in body • Resistant to head turn • C-curve in back and shoulders

i) <u>Frequently Present</u>

None of the SH parameters obtained a prevalence of 75.00% and more.

Body sway (94.17%-95.83%, n=113-115) was frequently present in five-year-old children performing the RIP position. Literature only states that balance needs to be considered if the child loses balance before turning the head (SAISI, 2005, p. 73). However, this parameter was observed after the children turned their heads in this study.

More than two thirds of the study population presented with the parameter, which might be indicative that it is reasonable to expect the parameter to be present in this age group. However, in view of the high incidence of possible un-integrated reflexes along with the findings of the SAE (cf. 5.3.7.3 i), the parameter might also be an indicator for the presence of the ATNR, as the body is unstable when the head is turned, bringing forth *body sway*. In spite of the fact that a large group of the study population obtained high grade scores on the RIP position, it is possible that the grade score allocation criteria, as compiled by the researcher, as a result of a lack of literature, was too lenient and should be revisited.

It remains relevant, however, to consider the RIP in addition to other observations of the presence of the ATNR (such as the quadruped testing position and SAE) before making a conclusion about the child's reflexes.

ii) Sometimes Present

The majority of the children were able to *assume the posture fluently* (70.83%-72.50%, n=85-87) and this is supported by Dunn's (1981, pp. 29-30) findings as she found 56.00% of the study population assumed the posture without experiencing difficulty.

Remaining parameters that were less frequently present were: *head held steady* (61.67%-63.33%, n=74-76), *straight leg* (55.83%-65.83%, n=67-79), *straight back* (48.33%-63.33%, n=58-76), *elbow flexion less than 25°* (41.67%-42.50%, n=50-51), *head in line with back* (35.83%-43.33%, n=43-52) and *able to independently keep chin against shoulder* (35.00%-42.50%, n=42-51). *Elbow flexion more than 25°* was sometimes present (40.83%-50.00%, n=49-60).

As the prevalence of the parameters *elbow flexion more and less than 25°* are very similar, either can be expected to be present in the typically developing five-year-old child. The therapist should not make a conclusion regarding the presence of the reflex based only on the *degree of elbow flexion* present in the RIP position, as no distinct difference on the degree of *elbow flexion more or less than 25°* was evident. The therapist should rather consider the duration the child is able to maintain the posture, as well as qualitative data as to the presence of parameters found to be seldom present in the population, which can be indicative of a possible difficulty.

iii) <u>Seldom Present</u>

One SH parameter: *leg and knee in line with hip* (19.17%-20.00%, n=23-24) was seldom present, and the five-year-old child should, therefore, not be expected to perform the RIP position with the *leg and knee in line with hip*.

SNH parameters seldom observed were: *associated reactions with the mouth* (15.00%-16.67%, n=18-20), *open shoulder and turn body* (13.33%-16.67%, n=16-20), *excessive lordosis* (10.83%-15.83%, n=13-19), *tends to lock elbows* (11.67%-14.17%, n=14-17), *retracts chin in body* (5.83%-8.33%, n=7-10), *resistant to head turn* (5.83%-7.50%, n=7-9) and *c-curve in back and shoulder* (0.00%-3.33%, n=0-4). The findings, therefore, suggest that these mentioned parameters could indicate areas of possible difficulty in the five-year-old child, especially if it clusters with other similar observations.

As previously stated, (cf. 5.3.5.1.3 ii), *resistance to head turning* can indicate a lack of integration of the ATNR (SAISI, 2005, p. 73). The parameter was observed more often during the ATNR test (45.83%, n=55) and its presence decreased drastically for the RIP test (5.83%-7.50%, n=7-9). In accordance with the previous discussion (cf. 5.3.5.1.3 i) the researcher would like to reiterate the importance of noting the *resistance to head turning* during the ATNR test, but also observing the RIP position before making a conclusion about the presence of the reflex.

5.3.5.2.4 SE differences on the observable characteristics of the RIP test

The only significant difference between the SE groups' performance on the RIP, was one SH parameter: *head in line with back* (p=0.04) when the head was turned to the right side. This parameter was more often observed in children from LSES (45.00%, n=27) than HSES (26.67%, n=16). The differences noted between the two groups on this parameter does not seem to have significant clinical value as it is an isolated parameter that only occurred on the left side, the parameter does not 'cluster' with any other observations, and the parameter was found to be sometimes present in both groups of the study population.

In conclusion, similar performance of both SE groups can be expected during the RIP test.

5.3.5.3 Symmetrical Tonic Neck Reflex (STNR)

5.3.5.3.1 Measurable characteristics of STNR test

According to Table 4.14, the majority of the children (59.17%, n=71) obtained a grade score of 1. For the purpose of the study, a grade score between 1-3 (cf. Appendix I 5.3) was allocated when elbow flexion of more than 45° was present during neck flexion. The findings indicate the majority of the study population (81.67%, n=98) experienced changes in flexor tone, presenting with elbow flexion of more than 45°.

The median degree of elbow flexion measured on the right side was 46.00°, with a Q_1-Q_3 range of 29.00° - 61.50°. For the left side, elbow flexion of 45.50° with a Q_1-Q_3 range of 30.50° - 61.50° was evident in the typical five-year-old population.

Ayres (1973, p. 102) states that when a child's head is flexed, and the flexor tone in the arms increases, it is indicative of a delayed integration of the STNR. Fiorentino (1973, p. 15) agrees, and also places emphasis on the presence of increased flexor tone in the arms, which is a positive reaction indicating the presence of the STNR. According to Dunn (1981, p. 27), elbow flexion more than 25° on the STNR is seen as "a considerable amount of joint change" and can be an indication of the presence of the STNR.

However, controversy exists on the different views on the assessment of primitive reflexes (Van Jaarsveld, 2010, p. 12), its presence in typically developing children (Capute 1978 in Capute et al., 1982, p. 314) as well as the implication of the presence of the reflexes past the expected age (Zafeiriou, 2004, p. 6). Nonetheless, the researcher cannot ignore the fact that a vast majority of the study population presented with an increase in flexor tone in the arms during neck flexion, indicative of a delayed integration of the STNR (Ayres, 1973; Fiorentino 1973 and Dunn 1981).

Other studies also found un-integrated primitive postural reflexes present in children younger than six years (Van Jaarsveld, 2010 and Clark, 2012). Van Jaarsveld (2010, p. 12) comments that "[i]t is true that the presence of primitive reflexes in children under the age of seven does not necessarily indicate dysfunction", but the author was of the opinion that if the reflexes do influence the child's functioning, it should be addressed.

When looking at the study population's measurable characteristics, a high incidence of the STNR was evident, and it is concerning. The researcher attempted to include only typically developing children, making provision to, as far as possible, exclude children with difficulties (cf. 3.2.2 a and 3.2.3 b), however, the functional abilities of the study population was not known. Even though previous studies alluded to the effect of un-integrated primitive postural reflexes (e.g., Jooste, 1989), the extent to which these reflexes might influence the study population functionally (e.g. with regard to midline crossing and tool use such as scissors and crayons (Van Jaarsveld, 2010, p. 13)) is unknown (cf. 6.5).

5.3.5.3.2 SE differences on the measurable characteristics of the STNR test

No significant differences were found within the two SE groups' grade scores (p=0.85) and degree of elbow flexion (p=0.98), suggesting similar performance on the STNR grade score allocation and degree of elbow flexion for both SE groups.

5.3.5.3.3 Observable characteristics of STNR test

Table 5.7 summarises the observable characteristics present in both groups while performing the STNR test and categorised according to the prevalence criteria.

Table 5.7: Summary of observable characteristic of STNR test

	Frequently Present	Sometimes Present	Seldom Present
NECK EXTENSION			
SH Parameters		• No changes in joint position	• Elbow flexion more than 25° • Posterior pelvic tilt • Rounded/arched back
SNH Parameters	• Anterior pelvic tilt • Lordosis of back	• Excessive extension of elbows • Tends to lock elbows • Resistant to head turn	
NECK FLEXION			
SH Parameter			• No changes in joint position
SNH Parameters	• Posterior pelvic tilt • Rounded/arched back • Elbow flexion more than 25°	• Tends to lock elbows • Resistant to head turn	• Anterior pelvic tilt • Lordosis of back • Excessive extension of elbows

i) <u>Frequently Present</u>

None of the SH parameters were frequently present.

During *neck flexion* the following parameters were frequently observed: *posterior pelvic tilt* (85.00%, n=102), *rounded/arched back* (84.17%, n=101) and *elbow flexion more than 25°* (81.67%, n=98). During *neck extension*, *anterior pelvic tilt* (94.17%, n=113) and *lordosis of back* (92.50%, n=111) were frequently observed.

The current COs (SAISI, 2005, p. 35) place emphasis on three observations during the STNR test, namely: elbow flexion, changes in trunk and pelvic tilt. However, the COs manual does not elaborate during what developmental stage these parameters should be present or absent, nor does it provide descriptive observations regarding trunk and pelvic tilt. In the study of DeGangi et al. (1980, p. 457) "only those children with severe delays had definite joint changes in flexion and extension." These authors also did not elaborate on the exact meaning of the term 'joint changes.'

If the STNR is present and the child's head is flexed, the flexor tone in the arms increases while the extensor tone increases in the lower extremities (Fiorentino, 1973, p. 15). As the effect of the STNR in the lower extremities is less profound (Ayres, 1973, p. 102) with the quadruped position not allowing the legs to fully extend, it is possible that the increased extensor tone influences the position of the pelvis, tilting it in a posterior position. The opposite occurs during neck extension. During neck extension, the extensor tone in the upper extremities increases, while the flexor tone increases in the lower extremities (Fiorentino, 1973, p. 16). The increased flexor tone in the lower extremities has an effect on the position of the pelvis, tilting it forward as the legs cannot flex further due to the quadruped position. Therefore, changes in the position of the pelvis can serve as further evidence of the presence of the STNR.

As the study population had definite joint changes in the arms and pelvis, it is indicative of the presence of the STNR. The high prevalence of the STNR in the study population is concerning, but as previously stated (cf. 5.3.5.3.1), the functional implication the reflexes might have on the study population is unknown, and care should be taken with the interpretation of the findings. Future studies in this regard are essential (cf. 6.5).

ii) <u>Sometimes Present</u>

During *neck extension*, *no changes in joint position* were sometimes observed (61.67%, n=74). This parameter refers to 0° elbow flexion and/or child lifting palms off the floor (cf. Appendix L). In her study, Dunn (1981) did not mention any findings with regard to testing STNR during neck extension. Even though the arms did not flex, *excessive extension of elbows* (70.83%, n=85) were present. According to Fiorentino (1973, p. 16), a positive reaction on the STNR test is increased extensor tone in the arms, causing the arms to extend, during neck extension.

Even though his administration differed from the one used in the study, as he positioned the children on the examiner's lap, the findings of a high incidence of *excessive extension of elbows*, can serve as further evidence of the presence of the STNR.

The remaining parameters of *locking elbows* (33.33%-44.17%, n=40-53) and *resistant to head turn* (25.83%-26.67%, n=31-32) were observed in both neck flexion and neck extension positions. Ayres (1973, p. 102) states, if a child gives *resistance upon head movement*, it is believed that the child is attempting to avoid the disorganising influence of the reflex. In the study of DeGangi et al. (1980, p. 457) the authors did not mention the prevalence of the parameter during testing of the STNR. However, they found children with severe delays presented with severe resistance during turning of the head with testing of the ATNR. It is possible that the parameter only occurred in children with severely delayed STNR, and the absence thereof does not necessarily mean an integrated STNR, but a less severe presence of the reflex.

iii) <u>Seldom Present</u>

No changes in joint position (11.67%, n=14) was seldom present during *neck flexion*. As previously stated, the parameter refers to no elbow flexion. The difference between this parameter and elbow flexion more than 25° (SNH parameters) indicates the children that presented with elbow flexion but less than 25°. The parameter theoretically points to the absence of the STNR reflex (Dunn, 1981). When interpreting the parameter based on literature described by Dunn (1981), the minority of the study population (18.33%, n=22) had *elbow flexion less than 25°*, which would be an indication of an integrated STNR.

Anterior pelvic tilt, lordosis and *excessive elbow extension* were never (0.00%, n=0) observed during neck flexion, together with *elbow flexion*, *posterior pelvic tilt* and *rounded/arched back,* which were never (0.00%, n=0) observed during neck extension.

5.3.5.3.4 SE differences on the observable characteristics of the STNR test

Only one SNH parameter: *resistance to head turn*, during neck extension, showed a significant difference (*p*=0.00) between the SE groups, as it was more often observed in the HSES (38.33%, n=23) compared to LSES (15.00%, n=9).

As previously stated, the parameter can be the child's attempt to avoid the disorganised effect of the reflex, and can be present in children with a severe delay in the reflex (5.3.5.3.3 ii). As the two SE groups performed similarly on the measurable characteristics (cf. 5.3.5.3.1), the researcher cannot, based on one isolated parameter, generalise that children from HSES might have more severe delays in the reflex, compared to children from LSES. The parameter should be considered as a whole in an effort to make meaning of patterns or clusters, should these occur in the child.

Concluding the tonic neck reflexes, the results indicate children from both SE groups would perform similarly on the tests.

5.3.6 Supine Flexion Posture (SFP)

5.3.6.1 Measurable characteristics of SFP test

According to Table 4.16, the majority of the children obtained a grade score of 4 and 5 (58.33%, n=70) with a median duration of 16.00 seconds and a Q_1-Q_3 range of 10.50-25.00 seconds. The findings are consistent with the current available literature, indicating a typical five-year-old child would be able to assume the SFP for 11-20 seconds (Dunn, 1981, p. 21).

5.3.6.2 SE differences on the measurable characteristics of the SFP test

No significant differences were found within the two SE groups' grade score (p=0.12) and duration to maintain the posture (p=0.18), evidence for similar expected performances on the SFP grade score allocation and duration for both SE groups.

5.3.6.3 Observable characteristics of SFP test

Table 5.8 summarises the observable characteristics present in both groups, while performing the SFP test and categorised according to the prevalence criteria.

Table 5.8: Summary of observable characteristic of SFP test

	Frequently Present	Sometimes Present	Seldom Present
SH Parameters		• Lift limbs simultaneously • Maintain posture against resistance • C-curve in upper trunk • Neck flexion more than 45°	• Head held steady
SNH Parameters	• Effort required • Shoulder elevation	• Fixation of upper limbs • Neck flexion less than 45° • Retract chin • Press feet together • Trunk and shoulders in line • Head lag before 10 seconds • Assumes posture segmented (lower limbs first) • Fixation of lower limbs • Place one foot over the other	• Assumes posture segmented (upper limbs) • Unable to count aloud • Grabbing onto clothes • Chin lead • Fisting of hands • Associated reactions with the mouth

i) Frequently Present

None of the SH parameters on the SFP test were frequently present, opposing the hypothesis that the SFP subtests' SH parameters should frequently be present.

However, two SNH Parameters were frequently present: *effort required to maintain posture* (85.83%, n=103) and *shoulder elevation* (75.00%, n=90). Studies involving the SFP in children aged five years (Fraser, 1986 and Dunn, 1981) did not provide any descriptive observations. However, Ayres (1972 in SAISI, 2005, p. 75) mentioned that children aged six years and older require moderate effort to maintain the posture. As these parameters were frequently observed, it is realistic to expect these parameters to be present in five-year-old children.

ii) Sometimes Present

The following parameters were sometimes present: *lift limbs simultaneously* (52.50%, n=63), *maintain posture against resistance* (44.17%, n=53), *c-curve in upper trunk* (43.33%, n=52) and *neck flexion more than 45°* (30.00%, n=36). Dunn (1981, p. 21) found the "with resistance posture" was too difficult for the majority of the five-year-old population and concluded that it is a reasonable expectation that the five-year-old child would maintain the SFP without resistance. Less than half of the study population were able to *maintain the SFP against resistance*.

The inability to *maintain the SFP against resistance* is thus not necessarily indicative of dysfunction among five-year-old children.

SNH parameters sometimes present with a high prevalence were: *fixation of upper limbs* (73.33%, n=88) and *neck flexion less than 45°* (70.00%, n=84). Remaining parameters with a slightly lower prevalence were: *retract chin in body* (61.67%, n=74), *press feet together* (58.33%, n=70), *trunk and shoulders in line* (56.67%, n=68), *head lag before 10 seconds* (50.00%, n=60), *lifting lower limbs first* (44.17%, n=53), *fixation of lower limbs* (43.33%, n=52) and *placing one foot over the other* (35.83%, n=43).

Limited descriptive literature on the SFP is available for the researcher to compare her findings. It is reasonable to expect the typical five-year-old child to *fixate the upper limbs*, have *neck flexion less than 45°* with *trunk and shoulders in line* and the presence of these parameters will not necessarily be an indication of poor somatosensory processing (Blanche, 2002, p. 15), when observed in the five-year-old population.

The remaining parameters were present in half of the population and less, indicating that the parameters can either be present or absent in the typical five-year-old child's performance on the SFP, and the therapist should interpret these observations carefully.

iii) <u>Seldom Present</u>

Head held steady (23.33%, n=28) was seldom observed in the study population and it should, therefore, not be expected of the five-year-old child to hold his or her *head steady* during assumption of the SFP.

Parameters seldom observed in five-year-old children were: *assumes posture segmented* (upper limbs first) (3.33%, n=4), *unable to count aloud* (23.33%, n=28), *grabbing onto clothes* (21.67%, n=26), *chin lead* (11.67%, n=14), *fisting of hands* (3.33%, n=4) and *associated reactions with the mouth* (3.33%, n=4). It is possible that the presence of the parameters *unable to count aloud*, *grabbing onto clothes* and *makes fists with hands* were strategies used by the children in an attempt to make the task easier, indicating the degree of difficulty experienced by the children to maintain the posture.

Chin lead and *associated reactions* were also seldom observed. The findings thus confirm that the presence of these parameters could serve as warning signs for possible immature nervous system or underlying sensory integration difficulties (SAISI, 2005).

5.3.6.4 SE differences on the observable characteristics of the SFP test

Only one SNH parameter: unable to *count aloud*, had a significant difference (p=0.00) between the SE groups, as it was more often observed in LSES (36.67%, n=22) compared to HSES (10.00%, n=6). The researcher is unsure if this was due to the specific group of LSES children experiencing more effort to maintain the posture and as a result not counting or whether the children from LSES were unfamiliar or uncertain how to count and, therefore, just kept quiet. A similar conclusion of the SFP can be made as described in 5.3.4.4, where children would perform similarly on the SFP test, but the *inability to count* aloud should be interpreted with caution in settings where children have not yet mastered the ability to count aloud.

5.3.7 SAE

5.3.7.1 Measurable characteristics of SAE test

According to Table 4.18, the minority of the five-year-old population obtained a grade score of 4 and 5 (30.83%, n=37), indicating that the minority of the study population presented with no postural changes. Based on these results, the therapist evaluating a five-year-old child, should be aware that postural changes can frequently occur in this age group.

5.3.7.2 SE differences on the measurable characteristics of the SAE test

No significant difference (p=0.79) was found on the performance of the two SE groups on the measurable characteristics of the SAE test, providing evidence of similar performances for both SE groups.

5.3.7.3 Observable characteristics of SAE test

Table 5.9 summarises the observable characteristics present in both groups, while performing the SAE test and categorised according to the prevalence criteria.

Table 5.9: Summary of observable characteristic of SAE test

STATIC POSITION			
	Frequently Present	**Sometimes Present**	**Seldom Present**
SH Parameters	• Maintain balance • No changes in upper limbs		
SNH Parameters		• Elevation of shoulders • Fixation of arms • No opening between fingers • Retracts chin in body	• Flexion of elbows • Asymmetry • Involuntary finger movements • Touching hands to stabilise arms • Arms separate • Associated reactions with the mouth • Dislike having eyes closed • Starting position not 90° • Arms raised more or less than 45° • Arms drop more or less than 45° • Spoon hands • Able to correct position of upper arms • Flexion of elbows • Thumb to palm • Hand drop • Asymmetry
HEAD TURN POSITION			
SH Parameters	• Maintain balance	• Dissociation of head from trunk (trunk rotation less than 45°)	• No changes in upper limbs
SNH Parameters	• Horizontal deviation of arms more than 45°	• Trunk rotation more than 45° • Elevation of shoulders • Fixation of arms • No opening between fingers • Arms separate • Arm drop (downward deviation more or less than 45°) • Spoon hands • Able to correct position of upper arms	• Retracts chin in body • Resistant to head turn • Flexion of elbows • Asymmetry • Involuntary finger movements • Touching hands to stabilise arms • Associated reactions with the mouth • Dislike having eyes closed • Starting position not 90° • Arms raised more or less than 45° • Thumb to palm • Hand drop

i) <u>Frequently Present</u>

For *static position*, all the SH parameters were frequently present. These include *maintain balance* when *eyes are closed* (99.17%, n=119) and *no changes in upper limbs* (81.67%, n=98). The results correlates with Dunn's (1981, p. 19) research as she found 84.00% of the children were able to maintain their arms in position during the SAE test with closed eyes. During *head turn*, only one of three parameters was frequently present, namely *maintain balance* when eyes are closed which was observed in all the participants (100.00%, n=120). According to Ayres (1973, p. 104) when closing of the eyes, the child's equilibrium may be distrubed and this may be suggestive of immature postural mechanisms. It is, therefore, realistic to expect that the typically developing five-year-old child would be able to *maintain balance* with eyes closed and during head turn position, and present with *no changes in the upper limbs* during the static position.

Only one SNH parameter, *horizontal deviation of arms* more than 45° (75.00%, n=90) was frequently observed. According to Touwen (1979, p. 50), slight deviation of the arms to the sides is common in children under six years, with 30°-60° deviation present in children aged three years. However, *horizontal deviation of the arms* more than 45° is often associated with poor dissociation of movements or a lack of integration of the ATNR (SAISI, 2005, p. 76). Studies have used the SAE test to assess the prevalence of the ATNR, and described the movement of the extended arms in the same direction as head movement, as a positive indicator of the presence of the reflex (McPhillips, Hepper, & Mulhern, 2000 and Anne & Black, 2005). Ayres (1973, p. 103) agrees and states that if marked changes in the posture of the arms are observed, it can be suggestive of the presence of the ATNR. Findings from the SAE test thus supports the findings from the ATNR test that were reported earlier (cf. 5.3.5.1.1) which suggested that the ATNR may not be integrated in a large percentage of the study population. However, when comparing the prevalence of parameters such as *horizontal deviation of the arms*, with *elbow flexion more than 45°* present in the ATNR and the ability to maintain the RIP, there were marked differences in the prevalence of the parameters. Hellebrandt et al. (1962 in Parr et al., 1974, p. 330) are of the opinion that the quadruped position is the most sensitive method when assessing the ATNR.

However, the specificity of the quadruped position has been called into question (Dunn, 1981 and Ayres , 1973) (cf. 5.3.5.1.1 and 5.3.5.1.3 i) and according to Ayres (1976 in SAISI, 2005, p. 76) the SAE should be interpreted with caution in children younger than six years. The researcher cannot ignore the fact that *horizontal deviation of the arms* was present in the majority of the study population, which is an indicator of the presence of the ATNR. However, the ability of the study population to maintain the RIP (cf. 5.3.5.2.1) for longer than 4 seconds, can also not be overlooked which would suggest that the ATNR may indeed be integrated in more children in this population than suggested by the ATNR test and the SAE *horizontal deviation* parameter. It is, therefore, suggested that the parameter of *horizontal deviation of the arms* must be interpreted along with the ATNR testing and RIP before making a conclusion about the presence of the reflex in a child, as the parameter might also be present in children with an integrated ATNR with merely poor dissociation of movement (SAISI, 2005, p. 76).

ii) Sometimes Present

During *head turn, dissociation of head from trunk* (49.16%, n=59) also marked as *trunk rotation less than 45°,* was sometimes observed in the study population. Dunn (1981, p. 18) found this parameter to be a normal expectation of five-year-old children. However, more children in the study, had *trunk rotation more than 45°* (50.83%, n=61). The results for the two parameters are very similar and *trunk rotation more than 45°* present in the five-year-old child*,* would not necessarily be indicative of a difficulty in vestibular-proprioceptive processing as described in literature (Blanche, 2002, p. 14). It would thus be probable that typically developing five-year-old children may present with *trunk rotation more or less than 45°* during the SAE test, with the amount of trunk rotation decreasing in children older than six years as suggested by SAISI (2005, p. 76).

Elevation of shoulders (49.17%-68.33%, n=59-82), *fixation of arms* (55.00%-65.83%, n=66-79) and *no opening between fingers* (40.83%-42.50%, n=49-51) were observed in both positions, with *retraction of chin* (51.67%, n=62) observed more often during the static position. These parameters can be associated with difficulty in performing the SAE test and can be associated with poor proprioceptive feedback, cerebellar integrity and/or indicate the degree of difficulty to perform the action (Blanche, 2002, p. 14). However, more than half of the study population presented with *elevation of shoulders*, *fixation of arms*, *no opening between fingers* and *retracted their chin*, and the prevalence of these parameters in typically developing five-year-old children may not be a definite indication of difficulty.

During *head turn*, the remaining parameters sometimes observed were *arms separate* (33.33%, n=40), *arm drop* (downward deviation more and less than 45°) (25.83%-32.50%, n=31-39), *spoon hands* (27.50%, n=33) and able to *correct position of upper arms* (27.50%, n=33). According to literature *deviation of the arms* is common in children under six years. However, the deviation is usually upwards (Touwen, 1979, p. 50), differing from the results found in this study. Ayres (1973, pp. 104-105) interpreted downward drift of the arms as a lack of automatic holding responses. Using activity analysis, under-developed shoulder stability may also account for a downward deviation.

As the parameter was observed in less than a third of the study population, it is possible that these individual children had difficulty maintaining the posture either due to a lack of holding responses and/or slight difficulty in shoulder stability. Nonetheless the parameter was sometimes observed and should be interpreted with caution if the parameter is present in typically developing five-year-old children.

According to literature, *spooning of the hands* should be interpreted cautiously as it can be an indication of hypotonia, laxity of joints and might be a result of training (Touwen, 1979, p. 52). As the parameter was observed in less than a third of the study population, the researcher agrees with Touwen (1979) that the parameter should be interpreted carefully. The parameter *correct position of upper arms*, is only mentioned by Touwen (1979, p. 50) as he states that children with hypotonia might over-correct positioning of the arms. With the use of activity analysis, the ability of the child to *correct positioning of the arms* can be seen as positive sensory feedback from the proprioceptive receptors located in the arm, and the inability to correct the position might indicate difficulty in the proprioceptive system (Touwen, 1979, p. 52).

However, based on the findings, less than a third of the study population were able to correct positioning of the upper arms and the absence of the parameter in typically developing five-year-old children, may not necessarily be indicative of poor proprioceptive feedback, as a large group of the study population did not present with this parameter.

iii) Seldom Present

During *head turn*, *no changes in the upper limbs* (2.50%, n=3) was seldom observed. This parameter refers to the child being able to maintain the original starting position without any deviation of the arms, either vertical or horizontal. According to Touwen (1979, p. 50), it is only expected of children older than six years to present with *no deviation of upper limbs*. The performance of children in this study thus corresponded with Touwen's suggestion. Typically developing five-year-old children might have changes in the upper limbs during the head turn position of the SAE test.

SNH parameters seldom present in both positions were *resistant to head turn* (4.17%, n=5), *flexion of elbows* (0.00%-2.50%, n=0-3) and *asymmetry* (4.17%-21.67%, n=5-26). According to literature, these parameters are indicative of an uninhibited ATNR (SAISI, 2005, pp. 76-77).

The parameter *resistance to head turn* was sometimes present in the study population during the ATNR test (cf. 5.3.5.1.3 ii) and drastically decreased during the RIP (cf. 5.3.5.2.3 iii) as it was seldom observed, similar to the results found for SAE test.

Resistance to head turn during SAE test and RIP are more in line and support the conclusion made in 5.3.5.2.3 iii, on the parameter *resistance to head turn*.

The remaining SNH parameters seldom observed were: *involuntary finger movements* (15.00%-22.50%, n=18-27), *touching hands to stabilise arms* (10.00%-13.33%, n=12-16), *associated reactions with the mouth* (0.83%-3.33%, n=1-4), *dislike having eyes closed* (0.00%, n=0), s*tarting position not 90°* (0.00%- 21.67%, n=0-26), *arms raised more or less than 45°* (0.00%-3.33%, n=0-4), *thumb to palm* (0.00%-10.00%, n=0-12) and *hand drop* (1.67%-7.50%, n=2-9). *Involuntary finger movements*, and *discomfort* performing the action were not present in the typical five-year-old population as reported by Dunn (1981, p. 19), supporting the findings of this study. *Associated reactions* according to literature, are indicative of an immature nervous system (SAISI, 2005), and the two parameters described by Touwen (1979, pp. 50-52), *upward deviation of arms* and *asymmetry* are respectively indicative of poor proprioceptive feedback, hemisyndrome and/or coordination difficulties. Ayres (1973, p. 104) states if children experience a negative emotional reaction, it can be indicative of immature postural mechanisms. From the findings one can expect the typically developing five-year-old child, not to present with these mentioned parameters, as literature confirms the presence of these parameters may indicate possible difficulties.

5.3.7.4 SE differences on the observable characteristics of the SAE test

There was a significant difference between the HSES and LSES group on one SNH parameter, namely *flexion of elbows* (p=0.01). The parameter was not observed in children from HSES, but present in children from LSES (5.00%, n=3). Still, in both groups, *flexion of elbows* was seldom present and is thus not expected in most typically developing five-year-old children. The difference between HSES and LSES groups, therefore, does not seem to be clinically significant and as found from the results, it can be expected not to be present in the typical five-year-old child.

In conclusion, children from diverse SES would perform similarly on the observable characteristics of the SAE test.

5.3.8 Finger-To-Nose (FTN)

5.3.8.1 Measurable characteristics of FTN test

According to Table 4.20, the majority of the children obtained a grade score of 4 and 5 (54.17%, n=65). Children obtaining a grade score between 3 and 5 were able to perform the FTN test. Using this reference point, the findings indicate that the majority of the children (72.50%, n=87) were able to perform the FTN test. The findings are consistent with literature from Dunn (1981, p. 16) and Touwen (1979, p. 61) (cf. 2.4.3 viii) who also found five-year-old children are able to perform the FTN without difficulties. The results indicate that typical five-year-old children will be able to perform the FTN test and the inability to do so can be an indication of poor motor control and planning (Mutti et al., 1998, p. 40).

5.3.8.2 SE differences on the measurable characteristics of the FTN test

No significant difference (p=0.46) was found on the performance of the two SE groups on the measurable characteristics of the FTN test, evidence of similar performances for both SE groups.

5.3.8.3 Observable characteristics of FTN test

Table 5.10 summarises the observable characteristics present in both groups while performing the FTN test and categorised according to the prevalence criteria.

Table 5.10: Summary of observable characteristic of FTN test

	Frequently Present	Sometimes Present	Seldom Present
SH Parameters		• Arms abducted 90° • Fluid and smooth movement • Touch tip of nose within 1.5 cm	• Miss tip of nose and able to correct
SNH Parameters		• Press hard on nose • Touch nose not with tip of finger • Retract chin	• Poor rhythm • Flexion of non-touching arm more than 45° • Turn head to side while touching nose • Fixate upper limbs • Replace finger with opposite hand • Associated reactions with mouth • Loses rhythm

i) Frequently Present

None of the SH parameters were frequently present, opposing the hypothesis that the FTN subtests' SH parameters should frequently be present. In addition, none of the SNH parameters obtained a prevalence of 75.00% and more. This supports the hypothesis that none of the FTN subtests' SNH parameters should frequently be present. Therefore, it is a realistic expectation that parameters, either classified as SH or SNH, should not be expected to be frequently present in the typically developing five-year-old child, as shown in the study, and it would not be indicative of possible difficulty.

ii) Sometimes Present

Parameters sometimes observed were: *arms abducted 90°* (69.17%-71.67%, n=83-86), *fluid and smooth movement* (68.33%-70.00%, n=82-84) and *touch tip of nose within 1.5 cm* (64.17%-65.83%, n=77-79). The findings correlate with literature described by Touwen (1979, p. 61) and Dunn (1981, p. 16), that five-year-old children are able to *touch the tip of their nose* and *perform the action smoothly and accurately* and if the child, in his attempt to touch the tip of the nose, misses or wanders in any direction it may indicate difficulty with body in space perception (Mutti et al., 1998, p. 41).

Press hard on nose (70.73%, n=85) was sometimes observed. Literature ascribes increase force as a lack of proprioceptive processing (SAISI, 2005, p. 63). There is thus a possibility that the majority of the study population had poor proprioceptive processing. Thus far, possible evidence for poor proprioceptive processing was found in the DDK test (cf. 5.3.1.3 ii), TFT (cf. 5.3.2.3 i and ii), ER (cf. 5.3.3.3 ii), SF (cf. 5.3.6.3 i) and SAE (5.3.7.3 ii), as parameters indicating poor proprioceptive processing was found to be either frequently or sometimes present. However, in cases where the parameters obtained high prevalence, the researcher used clinical reasoning to conclude that the parameters present used in a compensatory manner, would not necessarily be indicative of a difficulty, as a large group of the study population presented with the parameter. However, in cases where the parameters were seldom observed obtained low prevalence (less than a third of the population), the researcher reiterated that the parameters should be interpreted with caution as a large group of the study population did not present with the parameter.

It is, therefore, difficult to ignore the fact that there is a possibility that individuals in the study population did experience poor proprioceptive processing, however, 70.83% (n=85) of the population *pressed hard on their nose,* which might be evidence that the compensatory use of force is not an indication of poor proprioceptive processing, but rather a parameter that might be typical to expect in the five-year-old child.

The remaining parameters sometimes present, were: *touch nose not with tip of finger* (35.00%-38.33%, n=42-46) and *retract chin* (29.17%, n=35).

According to Touwen (1979, p. 61), children older than five years should be able to put the fingertip on the tip of the nose. It was observed in the study that children did not use the fingertip but touched the nose with the distal or middle phalanges of the finger, even though the researcher clearly instructed the children and made use of demonstrations. It is possible that the children did not fully understand the instructions and/or did not notice that the researcher used the tip of the finger to touch the nose. This might be a contributing factor why the parameter was sometimes observed.

iii) <u>Seldom Present</u>

Miss tip of nose and able to correct it (5.83%-10.83%, n=7-13) were seldom present in the typical five-year-old child. From the findings (cf. 5.3.8.3 ii) a large group of the study population touched the tip of their nose and, therefore, did not need to correct themselves. Between 34.17%-35.90% (n=41-43) of the children were unable to touch the tip of the nose, and of these only 5.83%-10.83% (n=7-13) corrected themselves after the error. As a result, 25.00%-28.33% (n=30-34) of the participants did not touch the tip of the nose, neither did they correct themselves. The findings are consistent with Dunn's findings (1981, p. 16), as 21.00% of the study population did not correct themselves after the error of not touching the nose. The parameter *miss tip of nose and able to correct it*, were seldom present in the study population as the majority of the population were able to correctly touch the tip of their nose. It is, therefore, more likely that typically developing five-year-old children would *touch the tip of their nose* more often than correcting themselves.

SNH parameters seldom present were: *poor rhythm* (13.33%-15.00%, n=16-18), *flexion of non-touching arm more than 45°* (15.00%, n=18), *turn head to side while touching nose* (8.33%-10.00%, n=10-12), *fixate upper limbs* (5.00%, n=6), *replace finger with opposite hand* (4.17%, n=5), *associated reactions with mouth* (4.17%, n=5) and *loses rhythm* (3.33%, n=4). Even though literature mentions symmetry, rhythm, smoothness, right/left differences and associated movements (Mutti et al., 1998, p. 59 and Blanche, 2002, p. 12), no descriptive observations were found. As a result, the researcher is unable to compare her findings with literature and can only conclude that based on the findings, most of the children in the study population performed the FTN test with adequate rhythm and coordination of the movement.

5.3.8.4 SE differences on the observable characteristics of the FTN test

A significant difference (p=0.04) was found on one SH parameter for the left hand, *miss tip of nose and able to correct position*. The parameter was more often observed in children from HSES (16.67%, n=10) compared to LSES (5.00%, n=3), indicating that more children from HSES missed the tip of the nose and were able to correct themselves.

A significant difference was found in one SNH parameter, *retracts chin in body* (right p=0.03 and left p=0.04). This parameter was more observed in children from LSES (right hand 38.33%, n=23 and left hand 36.67%, n=22) compared to HSES (right hand 20.00%, n=12 and left hand 20.00%, n=12).

Both parameters, *miss tip of nose and able to correct position* and *retracts chin in body* were overall found to be seldom present in the study population and, therefore, do not present any clinical significance. The results indicated that the parameters should not be expected to be present in the typical five-year-old child.

In conclusion, it is, therefore, a realistic expectation that children from diverse SES would present with similar observable characteristics when performing the FTN test.

5.3.9 Gaze Stability (GS)

5.3.9.1 Measurable characteristics of GS test

According to Table 4.22, the majority of the children obtained a grade score of 4 and 5 (58.33%, n=70). A grade score of between 3-5 is indicative of the child's ability to fixate the eyes on an object, while moving the head. As the majority of the children (88.33%, n=106) fell within this group, it is evident that most five-year-old children in this study population were able to execute the GS test, and the inability to maintain GS can suggest difficulty in the vestibular-ocular reflex as described in literature (Ayres 1972 in SAISI, 2005, p. 58).

5.3.9.2 SE differences on the measurable characteristics of the GS test

No significant difference (*p*=0.18) was found on the performance of the two SE groups on the measurable characteristics of the GS test, thus this provides evidence for similar performances for both SE groups.

5.3.9.3 Observable characteristics of GS test

Table 5.11 summarises the observable characteristics present in both groups, while performing the GS test and categorised according to the prevalence criteria.

Table 5.11: Summary of observable characteristic of GS test

VERTICAL HEAD MOVEMENT			
	Frequently Present	**Sometimes Present**	**Seldom Present**
SH Parameters	• Smooth bilateral coordination of the eyes • Eye movement independent from head movement • Stable gaze when head moves	• Smooth movement of the head	
SNH Parameters		• Fixation of upper limbs • Don't move head through full range of motion • Over-exaggerated head movement	• Slow movement • Action uncoordinated • Associated reactions of the mouth
HORIZONTAL HEAD MOVEMENT			
SH Parameters	• Smooth bilateral coordination of the eyes • Eye movement independent from head movement • Stable gaze when head moves	• Smooth movement of the head	
SNH Parameters		• Fixation of upper limbs • Don't move head through full range of motion • Lose eye contact when object is in peripheral vision • Action uncoordinated	• Over-exaggerated head movement • Slow movement • Associated reactions with the mouth

i) Frequently Present

Most of the SH parameters were frequently present, supporting the hypothesis that SH parameters of the GS test should be present in the typical five-year-old child.

Smooth bilateral coordination of the eyes (90.00%-91.67%, n=108-110), *eye movement independent from head movement* (83.33%-86.68%, n=100-104) and *stable gaze when head moves* (80.00%-80.83%, n=96-97) were frequently observed. Even though Dunn (1981, p. 4) did not include testing of GS, she found it is reasonable to expect smooth and coordinated eye movements in five-year-old children. Gilligan et al. (1981, pp. 253-254) also found the majority of their study population had adequate bilateral coordination of the eyes as the skill matures at three years of age.

The findings of the study correspond with previous findings in literature that the five-year-old child should be able to coordinate eye movements fluently.

ii) Sometimes Present

Smooth movement of the head (41.67%-44.17%, n=50-53) was sometimes observed. Based on the lower prevalence of *smooth movement of the head*, it may be more appropriate to rely more on the eye movement and the child's ability to focus on the object (cf. 5.3.9.3 i) and not expect five-year-old children to have *smooth movement of the head*, as it was observed in less than half of the population.

Remaining parameters sometimes present were: *fixation of upper limbs* (47.50%, n=57), *don't move head through full range of motion* (30.83%-32.50%, n=37-39), *losing eye contact when object is in peripheral vision* (30.00%, n=36), *over-exaggerated vertical head movement* (26.67%, n=32) and *uncoordinated action* during horizontal movement (27.50%, n=33). Based on activity analysis, these parameters may be indicative of a difficulty, as the child may need additional proprioceptive input to make the task easier, by *fixating the upper limbs*. If a child *does not move the head through the full range of motion*, it might be due to the fact that the child finds it easier to control limited head movement as the possibility exists that the task is too difficult, and the child will lose eye contact with the object, when he moves his head through the full range of motion. A child who *loses eye contact with the object when in peripheral vision*, might do so because of a poor vestibular-ocular reflex, not providing a compensatory motion in the opposite direction (Kiernan, 1998, p. 403), thus not enabling the retina to observe a steady image (Mohammad et al., 2011, p. 277). Lastly, *over-exaggerated head movemen*t might indicate motor control difficulties and an uncoordinated action is abnormal in children beyond infancy (Mutti et al., 1998, p. 58).

The findings should be interpreted with caution when present in five-year-old children, as possible signs of difficulty have been highlighted in literature and activity analysis. In addition, a large percentage of the study population did not present with these parameters.

iii) <u>Seldom Present</u>

None of the SH parameters were seldom present, opposing the hypothesis that the GS subtests' SH parameters should frequently be present.

Parameters seldom observed were: *over-exaggerated horizontal head movement* (14.17%, n=17), *slow movement* (5.83%-20.83%, n=7-25), *uncoordinated action* when head moves vertically (13.33%, n=16) and *associated reactions with the mouth* (12.50%-14.17%, n=15-17). The same reasoning and activity analysis as described in 5.3.9.3 ii, applies for *over-exaggerated head movement*, *slow head movement* and *uncoordinated action*. For the parameter *associated reactions with the mouth*, literature has emphasised that the parameter can be indicative of an immature nervous system (SAISI, 2005, p. 62).

From the findings, typically developing five-year-old children should not present with *over-exaggerated horizontal head movement*, *slow head movement*, *uncoordinated action* and *associated reactions* while performing the GS test.

5.3.9.4 SE differences on the observable characteristics of the GS test

One SH parameter, *stable gaze* when head moves *horizontally* showed a significant difference (p=0.04) on the performance of the two SE groups, as the parameter was observed more in children from HSES (88.33%, n=53) compared to LSES (73.33%, n=44). The results indicate that a *stable gaze* during horizontal head movement might be observed more in children from HSES compared to LSES.

It was evident from the results that during horizontal head movement, two SNH parameters obtained significant differences (p=0.00 and p=0.05 respectively). *Over-exaggerated movement of the head* was observed more in children from LSES (23.33%, n=14) compared to HSES (5.00%, n=3), with similar findings for *losing eye contact when in peripheral vision*, as the parameter was present more in children from LSES (38.33%, n=23) compared to HSES (21.67%, n=13). One SNH parameter, *uncoordinated action* (p=0.01) during vertical head movement, also had a significant difference, as it was observed more in children from LSES (21.67%, n=13) compared to the HSES group (5.00%, n=3).

In conclusion, lower prevalence of a SH parameter, and higher prevalence of three SNH parameters suggest that from a qualitative observational perspective, children from the LSES group had more difficulty in performing the GS test despite similar grade scores obtained.

The therapist should be aware that children from both HSES and LSES can obtain similar grade scores (cf. 5.3.9.1). However, one might observe more SNH parameters in children from LSES, compared to children from HSES.

5.3.10 Standing Balance (SB)

5.3.10.1 Measurable characteristics of SB test

According to Table 4.24, the majority of the children obtained grade scores of 4 and 5 during the balance test with eyes open (right leg 60.83%, n=73 and left leg 66.67%, n=80). The median time was 9.50-10.50 seconds with a Q_1-Q_3 range of 5.00-22.00 seconds. The findings are consistent with literature, stating children aged five-years are able to maintain balance on one leg for 10.00-12.00 seconds (Touwen, 1979, p. 78; Thorpe 1975 in Mutti et al., 1998, p. 62 and OTASA 2009), and the inability of the five-year-old child to balance on one leg for this duration might be indicative of difficulties with vestibular-proprioceptive processing (O'Brien & Williams, 2010, p. 256).

However, a definite difference in the study population’s ability to balance on one leg with eyes closed was evident. During the balance task with eyes closed, lower grade scores were obtained. The majority of the children obtained grade scores of 1 and 2 (right leg 68.90%, n=82 and left leg 70.84%, n=85). A decrease was also evident in the duration.

A median of 2.00 seconds with a Q_1-Q_3 range of 1.00-4.00 seconds was evident. According to the Southern California Sensory Integration and Praxis Tests (SCSIT) (Ayres, 1980, p. 132), children aged five years six months to five years eleven months must balance on one leg with eyes closed, for a duration of three seconds for the action to be seen as typical.

The results of the study suggest that the position might have been too difficult for the study population to maintain, bearing in mind their age, and as a result they received low grade scores. The findings are consistent with research done by Condon and Cremin (2014, pp. 4, 5), who also found a decrease in the ability to balance on one leg with eyes closed compared to balancing with eyes open, of children aged four to five years.

It is, therefore, a realistic expectation that typically developing five-year-old children would not be able to balance on one leg with eyes closed for longer than 4.00 seconds and it would not necessarily be indicative of difficulties in vestibular-proprioceptive processing (O'Brien & Williams, 2010, p. 256), as the ability to balance on one leg with closed eyes increases as the child gets older (Condon & Cremin, 2014, p. 5).

5.3.10.2 SE differences on the measurable characteristics of the SB test

A significant grade difference on the measurable performance was found between the SE groups on balancing on the *left leg* with *eyes open* (p=0.03) and *closed* (p=0.04). During balance on the *left leg* with *eyes open*, differences can be observed in the allocation of grade score 5 and 2. Sixty-five percent (65.00%) (n=39) of the children from HSES obtained a grade score of 5, with only 38.33% (n=23) of LSES obtaining a grade score of 5. Only 3.33% (n=2) of HSES obtained a grade score of 2, compared to the 16.67% (n=10) of LSES, who received a grade score of 2. Children from HSES, therefore, performed markedly better on this item than children from LSES. A significant time difference (p=0.03) was also evident for the left leg, as the HSES median duration in seconds (12.50 seconds), was higher compared to the LSES group (9.00 seconds). Even though the duration to maintain balance on the left leg with eyes open differs in the two groups, the duration for both groups were more or less in line with the norms described in literature (cf. 5.3.10.1).

During balance on the *left leg* with *eyes closed*, the majority of LSES obtained lower grade scores when compared to HSES. This can be seen during the allocation of grade score 2, where 51.67% (n=31) of LSES obtained the grade score, as compared to the 31.67% (n=19) children from HSES. More children from HSES (21.67%, n=13) obtained a grade score of 3, when compared to LSES (6.67%, n=4).

Differences were found only in the left leg. Touwen (1979, p. 78) states differences in the performance of the dominant and non-dominant leg is the greatest between four and five years of age.

A possible explanation for the difference seen between the two SE groups is the fact that "balance can be viewed as a skill, acquiring through training or play and development" (Condon & Cremin, 2014, p. 1).

As SES has an effect on a child's physical environment (Case-Smith, 2010, pp. 58, 77), it is possible that children from HSES might be more exposed to structured developmental play activities such as monkeynastixs, where they are provided with the opportunity to practice balancing on the dominant and non-dominant leg. The opportunity and exposure to a variety of sensory nourishment are important in the development of balance (Ayres, 2005, pp. 38, 41), and might explain the difference between HSES and LSES ability to balance on the left leg. The researcher, therefore, concludes that the findings are of clinical value to the therapist, and it is reasonable to expect that children from HSES might perform better balancing on the left leg, than children from LSES.

5.3.10.3 Observable characteristics of SB test

Table 5.12 summarises the observable characteristics present in both groups while performing the SB test and categorised according to the prevalence criteria.

Table 5.12: Summary of observable characteristic of SB test

	Frequently Present	Sometimes Present	Seldom Present
EYES OPEN			
SH Parameters	• Maintain arms in sides	• Body sway • Bracing against leg • Exaggerated movement of the arms and trunk • Anterior pelvic tilt • Eyes or head not steady	
SNH Parameters	• Toe and ankle movement without displacing the feet		• Fixating body • Shift supporting foot • Shoulder elevation • Asymmetry • Associated reactions with the mouth • Use vision to look at feet • Grabs onto clothing
EYES CLOSED			
SH Parameters	• Maintain arms in sides while balancing on right leg	• Maintain arms in sides while balancing on left leg	
SNH Parameters	• Toe and ankle movement without displacing the feet	• Body sway • Bracing against leg • Exaggerated movement of the arms and trunk • Anterior pelvic tilt • Fixating the body	• Shift supporting foot • Shoulder elevation • Asymmetry • Associated reactions with the mouth • Use vision to look at feet • Grabs onto clothing

i) Frequently Present

Maintain arms in sides were frequently observed (80.83%-85.00%, n=97-102) during the balance task with open and closed eyes. Since the vast majority of the study population were able to *maintain their arms in the side* while balancing, it is a realistic expectation for children aged five years to be able to *maintain their arms in the sides* during a balance task. The inability to do so might be indicative of the degree of difficulty the child experiences to equalise the two opposing gravitational forces (Williams 2007 in O'Brien & Williams, 2010, p. 252) or possible poor trunk control (O'Brien & Williams, 2010, p. 252), therefore, the child needs to use the arms in a compensatory manner to add more stability.

Toe and ankle movement without displacing the feet (85.83%-90.83%, n=103-109) was the only SNH parameter frequently observed. Touwen (1979, p. 68) supports the findings of this study as he states, children under the age of six years, need *toe and ankle movement without displacing the feet*, in order to maintain balance, when eyes are closed. The presence of the parameter can be expected to be present in typical five-year-old children and does not seem to be an indication of a difficulty.

ii) <u>Sometimes Present</u>

Maintain arms in sides during balance on the left leg with closed eyes (72.50%, n=87), received a slightly lower prevalence of 75.00%, but was also present in a large group of the study population (cf. 5.3.10.3 i). Remaining parameters sometimes observed in the study population balancing on one leg with eyes open and closed were: *body sway* (56.67%-73.33%, n=68-88), *bracing against leg* (37.50%-56.67%, n=45-68), *exaggerated movement of the trunk* (35.00%-65.00%, n=42-78), *anterior pelvic tilt* (40.83%-45.00%, n=49-54) and *eyes or head not steady* (45.00%-46.67%, n=54-56), with *fixation of body* (49.17%, n=59), more often observed during balance with eyes closed. These parameters can be used as a compensatory method to maintain the child's centre of mass over the supporting base, in order to be able to balance on one leg.

From the results, it is clear that *body sway* was more present during balance with eyes open with *exaggerated movement of the arms and trunk* more present during balance with closed eyes. *Body sway* and *exaggerated movement of the arms and trunk* shows the degree of difficulty the child is experiencing equalising the opposing gravitational forces (Williams 2007 in O'Brien & Williams, 2010, p. 252). *Bracing against the opposite leg* provides the child with an added form of stability. Hip strategies are often used to provide added stability and prevent falling (Shumway-Cook & Woollacott, 2012, p. 289), which was evident in the study population as they presented with *anterior pelvic tilt.* Lastly, *fixation of the body* provides additional proprioceptive feedback. As found from literature and activity analysis, the presence of these parameters can be indicative of a possible difficulty. However, a large group of the study population presented with the parameters.

The presence of the parameters *body sway, bracing against leg, exaggerated movement of the trunk, anterior pelvic tilt, eyes or head not steady* and *fixation of body during closed eyes*, should be dealt with cautiously, and should be considered as a whole along with other similar observations, in an effort to make meaning of patterns or clusters should these occur in the child.

iii) Seldom Present

Parameters seldom present were: *fixating body* while balancing with open eyes (19.17%-20.00%, n=23-24), *shift supporting foot* (16.67%-22.50%, n=20-27), *shoulder elevation* (13.33%-16.67%, n=16-20), *asymmetry* (1.67%-12.50%, n=2-15), *associated reactions with the mouth* (11.67%-19.17%, n=14-23), *use vision to look at feet* (5.83%-7.50%, n=7-9) and *grabs onto clothing* (0.83%-5.00%, n=1-6). These parameters are associated with difficulty in performing a balance task, and can through activity analysis be associated with poor proprioceptive processing and poor trunk control. *Asymmetry* can be indicative of lateralisation problems (Touwen, 1979, p. 79), while *associated reactions with the mouth* can indicative nervous system immaturity (SAISI, 2005). As the study population seldom presented with *fixation of body* during open eyes*, shift supporting foot, shoulder elevation, asymmetry, associated reactions of the mouth, use vision to look at feet* and *grabs onto clothing*, the parameters should be carefully noted by a therapist when they do occur in a five-year-old child, as they may indicate possible difficulties and should be investigated further through more comprehensive assessment.

5.3.10.4 SE differences on the observable characteristics of the SB test

Significant differences were found on the SNH parameters.

Balancing on the *right leg with eyes open, bracing against the opposite leg* and *shift supporting* foot showed a significant difference (p=0.03 and p=0.05) between the SE groups. More children from HSES *braced against the opposite leg* (60.00%, n=36) and *shifted the supporting foot* (30.00%, n=18), compared to LSES (40.00%, n=24 and 15.00%, n=9).

Balancing on the *left leg with eyes open, shoulder elevation* had a significant difference (p=0.02). The parameter was more present in children from HSES (21.67%, n=13) compared to LSES (6.67%, n=4).

Balancing on the *right leg with eyes closed, body sway* had a significant difference (*p*=0.01), as the parameter was more present in LSES (68.33%, n=41), compared to HSES (45.00%, n=27).

From the findings it is clear that the two SE groups used different strategies to maintain balance. HSES relied more on *bracing against the opposite leg*, *shift supporting foot* and *elevation of shoulders* to maintain balance, compared to the LSES who made use of *body sway* more. It is interesting that two parameters used by the children from HSES group were found to be seldom present in the study population as a whole (cf. 5.3.10.3 iii). In addition, the majority of the parameters were present during balancing on the right leg, the same leg that did not obtain any significant difference in the grade score allocation or duration in seconds. As the parameters did not occur consistently during eyes open and closed as well as during balance on the right and left leg, it is difficult to interpret such isolated observations, and differences in SH and SNH parameters will be considered as a whole in an effort to make meaning of patterns or clusters should these occur.

In conclusion, the SB test indicated differences in the observable characteristics of children from HSES and LSES. The differences can be ascribed to different strategies used by children to assist in maintaining balance and therapists must be aware that it is possible for children from HSES to present with different parameters to children from LSES.

5.4 Conclusion

In this chapter, the results of the study were discussed. A description of the participants was provided, followed by the discussion of the ten selected COs items.

The results presented in this chapter addressed the aim of the study, to describe the performance of typical five-year-old children from Mangaung Metro on ten selected COs items, by meeting the objectives of the study:

- The measurable characteristics of each COs item were discussed and quantitative data was provided for DDK, PEP, ATNR, RIP, STNR, SFP and SB tests. Most of the quantitative data was consistent with literature, with the exception of the results of items testing the presence of reflexes (ATNR and STNR).
- The observable characteristics of each COs items were discussed according to the SH and SNH parameters present in the study population. Descriptive observations became evident for the study population, which was categorised into three groups according to a prevalence criteria and summarised in table format. A discussion and the implication for the presence and/or absence of the parameters in the study population was also conversed.
- SE differences on both measurable and observable characteristics of each COs item were discussed. Slight differences were evident between the SE groups, with similar performances found on the majority of the subtests. There were, however, prominent differences found in the performance of the children on the TFT and SB test, which was concluded to be of clinical significance, influenced by the degree of skill required to perform the actions. Considering then, that the performance of COs items can be influenced by previous exposure to learning or can be dependent on basic sensory-motor functioning, the researcher summarised in Table 5.13, which items on the COs seem to be more dependent on skill development than basic sensory-motor functioning, as found from the results of the study. While actions such as PEP and SFP may also rely in part on previous exposure, the result suggests that basic sensory-motor functioning plays a more important role in these observations.

Table 5.13: Summary of COs dependent on skill or basic sensory-motor functioning

	DDK	TFT	ER	PEP	REFLEXES	SFP	SAE	FTN	GS	SB
Influenced by skill	**X**	✓	**X**	**X**	**X**	**X**	**X**	**X**	**X**	✓
Basic sensory-motor functioning	✓	**X**	✓	✓	✓	✓	✓	✓	✓	**X**

The final conclusion, recommendation for future studies, limitations of the study and the implications thereof on the interpretation of results, will be presented in Chapter 6.

CHAPTER 6

Conclusions, recommendations and limitations

6.1 Introduction

In Chapter 5, the results of the study were presented, argued and interpreted using relevant literature. In this chapter, the context and purpose of the study will be revisited, followed by the general conclusion in pursuit of the research objectives. Contribution to knowledge and recommendations for possible future research will be provided, followed by the limitations of the study. The chapter is ended with a closure.

6.2 Revisiting the context and purpose of the study

In the profession of occupational therapy (OT), sensory integration (SI) theory is well researched and used by South African (SAn) occupational therapists (OTs) as an approach of assessment and intervention (cf. 1.1). One of the more cost-effective assessment instruments used in SI, are Clinical Observations (COs), originally developed by Ayres, to supplement standardised tests such as the Sensory Integration and Praxis Tests (SIPT), in order to make an SI diagnosis. These observations referred to as Ayres Clinical Observations (ACOs) have been researched by several researchers (cf. 1.1 & cf. 2.4.1), however, not on the SAn population, even though findings indicate that the COs are widely used among SAn OTs (cf. 2.2.1).

SAn OTs are thus assessing and comparing SAn children to norms researched on children residing in the United States (US), even though discrepancies in literature between the performances of the two groups are prevalent (cf. 2.2.2). In addition, even though research in South Africa (SA) has been done on the performance of SAn children on assessment measures such as the SIPT (Van Jaarsveld et al., 2012) and Gross Motor Clinical Observations (Cook et al., 2004) (cf. 2.4.2), limited research has been done on the typical age-related performance of children engaging in the COs. The question asked was, how fair and accurate are OTs assessment results when using the COs, as performance noted by the therapist are currently interpreted without knowing the typical age-related performance of SAn children.

This led the researcher to investigate the performance of typically developing five-year-old children from Mangaung Metro district on ten selected ACOs items, in order to enhance the accuracy of the COs assessment and interpretation thereof when used on SAn children. In addition, based on previous findings in literature indicating differences in performance between socio-economic (SE) groups, a comparison was also made between the performance of children from high and low SE groups respectively. Although the sample was drawn to include an equal number of boys and girls, a comparison between the performance of different genders was not part of the objectives of this study.

6.3 Conclusions – Answering the research questions

Based on the findings, a conclusion will be drawn for each of the three research objectives.

6.3.1 Conclusion to objective 1: Describe the measurable characteristics of five-year-old SAn children's performance on the ten COs subtests.

The measurable characteristics included a grade score allocation and quantitative data.

a) Grade score allocation

The overall grade score allocation for children aged five years six months to five years eleven months on the majority of the COs subtests were grade scores of 4 and 5, indicating it can be expected of children of this age group to engage adequately in the subtests (Cook et al., 2016) and the inability to do so, might be an indication of possible difficulty. However, the majority of participants obtained low grade scores (1 and 2) on the following aspects of the COs: Thumb finger touching (TFT), testing of reflexes (Asymmetrical Tonic Neck Reflex (ATNR); Symmetrical Tonic Neck Reflex (STNR)), Schilder's Arm Extension (SAE) and Standing Balance with (SB) eyes closed.

For *TFT*, the researcher concluded that TFT may not be a good indicator of function vs. dysfunction in five-year-old children (cf. 5.3.2.1) as the performance on this item varied a great deal and a low grade score on the existing scoring system in five-year-old children would thus not be an indication of difficulty.

More than two thirds of the study population obtained low grade scores during testing of the *Tonic Neck Reflexes*, as definite changes in joint positions were observed. Although many children were able to assume the reflex inhibiting position (RIP), body sway during the RIP, changes in joint position during quadruped testing for the ATNR, as well as horizontal deviation of the arms during the SAE test, raises concern over the integration of primitive postural reflexes in the study population. At the same time, however, concern was also expressed over the specificity of the quadruped testing of the ATNR based on the degree of elbow flexion. Therefore, the study served to reiterate the importance of considering all the available evidence regarding reflex integration, including the RIP and SAE test, before drawing conclusions about a child's integration of primitive postural reflexes. Furthermore, the functional implications of the apparent lack of reflex integration in the study population is unknown and should be investigated in future studies (cf. Recommendations).

With ATNR, additional observations are available to assist the researcher in the reasoning process, however, this is not the case with STNR. With STNR, similar results to the ATNR were found, as more than two thirds of the study population also obtained low grade scores on the STNR test. A considerable amount of joint changes were evident in the study population, which can be an indication of lack of integration of the STNR (cf. 5.3.5.3.3. i). Considering the controversy on the different views on the assessment of primitive reflexes (Van Jaarsveld, 2010, p. 12), and the high incidence of postural changes noted in the study population, further investigation into the "utility" (Greenhalgh, 1997, p. 541) of the current assessment process is necessitated, in order to establish whether this assessment process is indeed valid and reliable in the assessment of reflexes.

During the *SAE* test, postural changes were seen in the majority of the study population. These postural changes varied with the most prominent postural change seen in horizontal deviation of the arms more than 45° (cf. Table 5.9).

The researcher concluded that the parameter can be indicative of an un-integrated reflex, or merely poor dissociation of movement. Postural changes present in the five-year-old population during SAE test, must be interpreted with caution and it is important to consider clusters when they do occur.

The *SB* results indicated the age group is able to adequately balance on one leg with eyes open, but a definite decrease in time and grade score allocation was evident during balance on one leg with closed eyes. The study supports the conclusion that the skill is still developing in five-year-old children. Lower grade scores when children balance on one leg with eyes closed, would not necessarily be indicative of difficulty in five-year-old children.

From the findings of the grade score allocation, most of the five-year-old population were able to perform the test, obtaining a grade score of 4 or 5. These tests namely: DDK, ER, PEP, SFP, FTN, GS and SB eyes open, can therefore be of value to therapists to possibly identify areas of difficulty in this age group. The findings of the grade score allocation also provided evidence of poorer performance of five-year-old children on the TFT, ATNR, STNR, SAE and SB eyes closed. Performing these mentioned tests, the therapist must be careful in the interpretation thereof with this age group, as it may not truly reflect the abilities of the five-year-old children due to various reasons (maturity in the nervous system and utility of assessing the reflexes).

b) Obtaining quantitative data

Quantitative data (such as number of repetitions or duration in seconds) was gathered for Diadokokinesis (DDK), Prone Extension Posture (PEP), ATNR, RIP, STNR, Supine Flexion Posture (SFP) and SB (cf. Chapter 4).

Most of the quantitative data of the study, except for those relating to reflexes, was found to be consistent with norms used in the COs (2005). This is interesting, as literature provides evidence of discrepancies in the performance on assessment instruments of children residing in SA and the US, which was not the case in this study (cf. 2.2.2). A possible answer for this finding may be that many of the COs test basic sensory-motor functions that are not dependent on the development of skills (which are more susceptible to environmental exposure differences) as opposed to skill-based items often included in standardised tests (cf. Table 5.13). It seems reasonable to deduce that the COs might be more widely applicable and fair to use on different population groups, where the OT uses her own clinical reasoning processes and is not guided by strict scoring ‘rules’.

The mean and interquartile ranges provided for each of the above-mentioned tests can be useful in clinical practice, as it can serve as a guideline for OTs to compare children's performance with the quantitative data obtained from the study.

6.3.2 Conclusion to objective 2: Describe the observable characteristics of five-year-old SAn children's performance on the ten COs subtests.

The researcher thoroughly described the observable characteristics of each COs items, through 'should have' (SH) and 'should not have parameters' (SNH) (cf. Chapter 4 & 5). In Chapter 5, a summary of each of the subtest's observable characteristics was provided in table format, according to prevalence criteria set for this study (cf. 5.1 b). It is the researcher's hope that these tables could contribute to the clinical usefulness of the research findings, through demonstrating which observations occur frequently, sometimes and seldom in a typically developing group of five-year-old children. It was evident from the findings that several hypothesised SH parameters should not always be expected to be present in the typical five-year-old child, with several SNH parameters occurring frequently, the presence of which would thus not necessarily indicate abnormality or dysfunction when testing a five-year-old child.

SH parameters grouped as *frequently present*, would be a reasonable expectation to be present in the five-year-old child. SH parameters *sometimes present*, might or might not be observed in the five-year-old child, and the absence of the parameters might not be indicative of possible difficulty. SH parameters *seldom present*, would be a reasonable expectation to be absent in five-year-old children and would not be indicative of possibly difficulty should these parameters not be observed in the child's performance.

SNH parameters grouped as *frequently present* would be a reasonable expectation to be present in the five-year-old child, and the presence thereof would not necessarily indicate difficulties. With reference to SNH parameters *sometimes* observed, the researcher reiterates that parameters present, might not always be indicative of possible difficulty. However, these should not be interpreted in isolation, but clusters need to be identified in order to come to a conclusion whether the parameter might be indicative of possible difficulty, especially in cases where a large group of the study population did not present with the parameters. Lastly, SNH parameters *seldom* observed, can most likely be indicative of possible difficulty when observed in the five-year-old child as most typically developing five-year-old children in this study did not display these parameters.

6.3.3 Conclusion to objective 3: Compare the performance of five-year-old SAn children, enrolled in lower and middle to high SE schools on the ten COs subtests.

SE differences were investigated on both grade score allocation and the parameters.

a) Significant differences on the measurable characteristics

The findings indicated the two SE groups performed similarly in most of the COs items with regard to the grade score allocations (cf. 5.3.5.1.2; 5.3.5.2.2; 5.3.5.3.2, 5.3.6.2; 5.3.7.2; 5.3.8.2 and 5.3.9.2). Literature points out that socio-economic status (SES) can influence a child's development (cf. 2.5.2) and consequently also a child's performance on measures of development such as the COs. However, children from diverse SES in this study population, in most instances, did not show marked differences on the performance of the 10 COs items. Even though slight differences between the SE groups were evident for *DDK* and *ER*, the researcher concluded that the differences have no clinical significance as both groups performed adequately on the subtests (cf. 5.3.1.2 and cf. 5.3.3.2). There were, however, two subtests found to have statistically and clinically significant differences in the performance of the two groups. The high socio-economic (HSES) group performed better on the TFT and SB test compared to their low socio-economic (LSES) counterparts. As both these tests are positively influenced by the development of a skill (cf. 5.3.2.2 and 5.3.10.2), the SE environment can impact on a child's performance and can thus be reflected in the results. The study population obtained similar scores on tests that are not dependent on skill, but performed differently once learned skill was required (cf. Table 5.13).

The findings of TFT and SB should be taken into consideration when testing and scoring children from diverse SESs on the COs.

b) Significant differences on the observable characteristics

Individual SH and SNH parameters on different COs items indicated significant differences on the performance of the two groups in various subtests, namely *DDK, TFT, ER, PEP, RIP, STNR, SFP, SAE, FTN, GS* and *SB*. However, when taking into account the isolated occurrence of differences in the parameters and the prevalence of the parameters according to the criteria stipulated in 5.1 b, the researcher concluded that the differences found in most of the COs items were not clinically significant (cf. 5.3.3.4; 5.3.5.2.4; 5.3.5.3.4; 5.3.7.4 and 5.3.8.4).

The *TFT* and *SB* subtests, did, however, show marked differences between the SE groups on the observable characteristics as was also noted in the measurable characteristics. As previously stated, both these tests require the development of a specific learned skill (cf. 5.3.2.2; 5.3.10.2 and Table 5.13) and the results indicate that children from HSES tended to perform better than their LSES counterparts when the action being tested is dependent on skill development rather than basic sensory-motor functions.

With *TFT*, five-year-old children from HSES also presented with more SH parameters, and children from LSES presented with more SNH parameters. With *SB* test, the findings indicated a possibility that children from diverse SES, present with different parameters as they might use different strategies to assist with maintaining balance (cf. 5.3.10.4).

Differences on observable characteristics on tests such as the *DDK, GS, PEP* and *SFP* were also present. Results from the *DDK* test found that, even though children from both SE groups performed adequately on the measurable characteristics, the HSES group had more SNH parameters, explaining why they obtained lower grade scores compared to their LSES counterparts. The opposite was found for GS, where LSES children had more SNH parameters present. For the *PEP* and *SFP* a similar parameter – *inability to count aloud* was more often obtained by children from LSES and the researcher concluded that this parameter must be interpreted with caution in settings where the ability to count is not yet mastered (cf. 5.3.4.4 and 5.3.6.4). Therapist should consider the findings of the *TFT, SB, DDK, GS, PEP* and *SFP* when assessing children from diverse SESs.

6.4 Contribution to existing body of knowledge

In terms of value to the OT profession, the study will contribute to the field of OT, on three levels:

a) Research level

- The research study addressed limitations in literature, as the literature available on COs is relatively old and limited research has been done on the use of the COs assessment tool on the SAn population. The study can, therefore, contribute to the expansion of literature on COs.

b) The profession's body of knowledge with regard to assessment

- SAn children were compared to US norms when assessed with the COs. The study allowed for more updated quantitative data on a group of SAn children.
- The study included children from both genders and from diverse SES, allowing the therapist working with either variables, to be able to compare her observations with the findings of this study, in order to assist with the assessment process. Although comparisons between the genders were beyond the scope of this study, data gathered during this study could be analysed further to obtain specific information regarding gender differences, if present, in this study population.
- Through the availability of more specific data on both measurable and observable characteristics of the COs, the results of this research will assist the therapist working in under-resourced communities, relying on the COs, to distinguish typical from atypical performance more accurately, impacting on more reliable assessment results.
- The findings will enhance the SI trained OT's reasoning on patterns of dysfunctions, as it is important in the clinical reasoning process to observe the manner in which the child executes the COs to assist in making a SI diagnosis (Van Jaarsveld, 2016).
- As several of the COs items are also included and used in neuro-developmental assessment (cf. 2.3.4), the findings will not only assist therapists trained in SI, but

will also be of value to the therapist working with a neuro-developmental frame of reference.

- Accurate assessment is important in planning effective intervention (cf. 2.2.1). The findings of the research will contribute to more accurate assessment and thus indirectly also assist with planning effective intervention. It can also contribute to curbing over- and under-servicing that results from inaccurate assessment.
- As the study population included children aged five years six months to five years eleven months, the study can assist the therapist in identifying children with problem areas before entering formal schooling.

c) The development of the COs measuring instrument itself

Expanding on the value of the study, the researcher consulted COs literature and compared it to the study's potential contribution to the measuring instrument, as depicted in Table 6.1.

Table 6.1: Possible contribution of the study (compiled by the researcher).

Literature	Possible contribution of the study to existing body of knowledge
"A science is marked by the quality and degree to which it measures the parameters of its field. Measuring instruments are critical tools for acquiring knowledge and it is difficult to acquire knowledge without them. The more precisely behaviour is measured the better it is understood" (Ayres in Mailloux, 1990, p. 589).	The study was structured and outlined to measure the parameters present in children engaging in the COs items. The findings contributed to the COs itself, as a measuring instrument, and furthermore precise behaviour was measured, enabling the OTs to better understand and interpret the behaviour seen during the COs.
COs assist the therapist in distinguishing typical behavioural patterns from immature behavioural patterns (Dunn, 1981, p. V), even though typical behavioural patterns are unknown.	The study identified typical performance patterns that can be expected in five-year-old children, contributing to the COs as a measuring instrument.
"…therapists may not be sure if they have measured dysfunction or normal sensory integration reliably… when they administer Ayres' Observations" (Norwood, 1999, p. 86)	The findings of the study were categorised for clinical usefulness, to provide OTs with a guideline of the expected parameters that should frequently, sometimes and seldom be present. This contributes to the OT profession's body of knowledge.

6.5 Recommendations

Based on the findings and conclusion, the following recommendations are made:

- The findings of the study should be submitted for possible inclusion in the COs of SAISI that is currently under revision (Cook et al., 2016).
- The findings should be published in accredited journals such as the South African Journal of Occupational Therapy to make the findings accessible to occupational therapists working in South Africa. It can also be presented at national and international congresses to disseminate the information more widely.
- The findings are also valuable to be used in the training material of upcoming SI trained therapists and current SI trained therapists, as the COs (SAISI 2005) is used in conjunction with the SIPT (Ayres, 1989) to identify children with SI dysfunctions in SA. The findings can be included and used for training purposes on SAISI SI qualification courses.

Recommendations for future research:

- Research on children aged five years six months to five years eleven months can be done on the **remaining COs items**.
- Research on this age group and children aged four and six years can be done on the COs items in **different geographical locations** of SA.
- Although this research gathered data for boys and girls separately, investigating gender differences was not part of the objectives of the study. Future research may investigate if significant differences between boys and girls on the COs items exist.
- It would be valuable to investigate the validity and reliability on the COs items on the SAn population.
- Although information on the effect of primitive reflexes on function is readily available on the internet, the researcher recommends, based on the results of this study, that current and formal research be done specifically on the extent to which the presence of reflexes in a typically developing study population might influence scholastic development, such as tool use, midline crossing and postural control.
- In future research involving individual subtests such as the PEP, all the children should be asked to maintain the PEP arms only position to establish a realistic

duration to maintain the posture, as only half of the study population took in the PEP arms only and made the results more difficult to interpret.

- In future studies the grade score allocation should not be based on the parameters present, as this made the interpretation of measurable and observable characteristics independently of one another difficult (cf. 5.3.3.1 and 5.3.5.2.3 i).

6.6 Limitations of the study

The following limitations should be considered when interpreting the results and conclusions of the study:

- The study population was limited to children aged five years six months to five years eleven months attending Grade R in Bloemfontein pre-schools. As a result, the study population is not representative of the whole SA.
- In addition, the study population only included 120 children, divided into two SE groups and two gender groups. Therefore, only 30 participants per gender per SE group were included in the study. This is a relatively small sample size that represented the larger population. Limited resources, referring to time and financial support, led to the restriction of the geographical environment and sample size.
- The COs are open to subjectivity (cf. 2.4.1 and cf. 2.4.3). Only one person was responsible for administering and scoring each child's performance (the researcher and a research assistant were each responsible for testing their own group of participants). In addition, limited research has been done on the validity and reliability of the COs, in particular considerations such as inter-rater reliability. However, strategies were employed to manage this limitation (cf. 3.2.4.4 b, c).
- No Quintile (Q) 1 and Q2 schools were included in the study. This was due to the schools either not meeting the inclusion criteria or the inability of the schools to accommodate the researcher with the data collection process, within the given time frame (cf. 3.2.3 a). Thus children from the very lowest and most deprived SE backgrounds did not form part of the study population, which could have slanted the results.
- With the PEP, the children who took in the PEP bent legs position could have been asked to rather take in the arms only position, as it could have changed the results,

since it would have possibly given a more realistic impression of the performance of five-year-old children on the PEP arms only position.

- The researcher's decision to base the allocation of grade scores partly on the presence of SH and SNH parameters might have influenced the measurable characteristics' results, and the researcher would recommend that this be avoided in future studies.

6.7 Closure

The aims and objectives of the study were addressed. By describing the performance of five-year-old children from Mangaung Metro on ten subtests of J Ayres based COs, on the measurable characteristics, observable characteristics and SE differences, the research has provided normative data on a small group of SAn children. This data can be used in clinical practice when interpreting the findings of COs on the population from which the study sample was derived.

SH and SNH parameters for all ten COs items included in this research were established and categorised into three categories based on their prevalence in the study population, and will be of value to the therapist identifying parameters that were found to be frequently, sometimes and seldom present in the typical five-year-old child performing the COs items. This will enhance the assessment process as the research allows the therapist to distinguish typical from atypical performance patterns more accurately.

SE differences were considered and performance by different SE groups were mostly similar. However, it is important to consider that differences might occur between the groups on items that require skill development, such as TFT and balancing on one leg.

Concluding this chapter, the researcher wishes to emphasise the need for on-going research on the norms, validity and reliability of the COs measuring instrument on children from diverse age groups and geographical environments in SA, to enhance the accuracy and fairness of OT assessments on children from SA.

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APPENDIX A

Approval letters to conduct study

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

IRB nr 00006240
REC Reference nr 230408-011
IORG0005187
FWA00012784

25 January 2017

MISS C POTGIETER
DEPT OF OCCUPATIONAL THERAPY
FACULTY OF HEALTH SCIENCES
UFS

Dear Miss C Potgieter

HSREC 164/2016 (UFS-HSD2016/1280)
PROJECT TITLE: THE PERFORMANCE OF FIVE YEAR OLD CHILDREN FROM MANGAUNG METRO ON TEN SUBTESTS OF J. AYRES BASED CLINICAL OBSERVATIONS

1. You are hereby kindly informed that the Health Sciences Research Ethics Committee (HSREC) approved this protocol after all conditions were met. This decision will be ratified at the next meeting to be held on 31 January 2017.

2. The Committee must be informed of any serious adverse event and/or termination of the study.

3. Any amendment, extension or other modifications to the protocol must be submitted to the HSREC for approval.

4. A progress report should be submitted within one year of approval and annually for long term studies.

5. A final report should be submitted at the completion of the study.

6. Kindly use the **HSREC NR** as reference in correspondence to the HSREC Secretariat.

7. The HSREC functions in compliance with, but not limited to, the following documents and guidelines: The SA National Health Act. No. 61 of 2003; Ethics in Health Research: Principles, Structures and Processes (2015); SA GCP(2006); Declaration of Helsinki; The Belmont Report; The US Office of Human Research Protections 45 CFR 461 (for non-exempt research with human participants conducted or supported by the US Department of Health and Human Services- (HHS), 21 CFR 50, 21 CFR 56; CIOMS; ICH-GCP-E6 Sections 1-4; The International Conference on Harmonization and Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH Tripartite), Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines, Constitution of the HSREC of the Faculty of Health Sciences.

Yours faithfully

DR SM LE GRANGE
CHAIR: HEALTH SCIENCES RESEARCH ETHICS COMMITTEE

Cc Janse Van Rensburg, Elize E

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education
Department of Education
FREE STATE PROVINCE

Mrs C Potgieter
6A Apollo Crescent
Pentagon Park
BLOEMFONTEIN, 9301

073 233 4899

Dear Mrs Potgieter

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.

   Research Topic: The performance of 5-year old children from Mangaung Metro on ten subtests of J. Ayres based Clinical Observations.

   Names of schools obscured for confidentiality

   Target Population: 160 five-year old Grade R learners.

2. **Period of research**: From the date of signature of this letter until 31 March 2017. 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. 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 attached ethics documents must be adheared 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: 13/01/2017

RESEARCH APPLICATION POTGIETER C PERMISSION JAN 2017
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

APPENDIX B

Permission letters to schools

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS·UV HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

Information document - Schools

Confidential

Dear Principal

I am a master's degree student at the University of the Free State, with an interest in children.

The following information will explain my study.

Occupational Therapists assess children to identify developmental difficulties in order to intervene. One of the methods of assessment is observations. An organisation called South African Institute of Sensory Integration (SAISI) has a Clinical Observation assessment tool which is used by Occupational Therapists to gain information about how a child uses their sensory systems, to engage in the environment through copying actions demonstrated by the therapist. Sensory systems include among others, the visual, sound and touch sense and gives the brain information about the environment and what our body is doing. Even though the document is valuable, there is an absence in research as to what is seen as typical age-related performance of children while engaging in these actions.

GOAL OF THE STUDY

The aim of this study is to desribe the performance of children aged five years six months to five years eleven months, from Mangaung Metro pre-schools on ten subtests of the Clinical Observations. As the assessment tool originated from America, research needs to be done on the South African population as children from America might differ from children growing up in South Africa.

BENEFITS OF THE STUDY

Participation in the study will contribute to research which can benefit future identification of risk areas in five-year-old children and can ensure early intervention to assist the child in school readiness.

RISK IN PARTICIPATING

There is no risk involved participating in the research study.

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UNIVERSITY OF THE FREE STATE
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YUNIVESITHI YA FREISTATA

SAMPLE POPULATION

Both boys and girls aged five years six months to five years eleven months will be included in the study. The study wish to include a sample of 120 children. The researcher will stop assessing children when she acquires her predetermined sample. It is, therefore, possible that not all the children who gives consent will be included in the study.

THE FOLLOWING WILL BE EXPECTED FROM THE SCHOOL

- Provide a room at the school with two small chairs, table and a carpet where the assessment can take place.
- Allow assessment in school time.
- Assist the researcher in identifying children meeting the inclusion criteria.
- Assist the researcher in her process of distributing and collecting consent documents from the parents.

THE FOLLOWING WILL BE EXPECTED FROM THE CHILDREN

- Give assent for participation and complete assent form.
- Performing ten subtests of the Clinical Observations, this include among others, standing on one leg, following an object with their eyes, balancing their body on a moving object, performing sequential thumb-finger touching and kneel stand while researcher turns their head to the sides.

ASSESSMENT AND VIDEO RECORDINGS

The children will be evaluated in the first term of 2017 (from January – March) in school time, from 08:00-13:00 with prior arrangements with the teachers. The duration of the assessment is 20-30 minutes per child. Each child will be assessed individually by the researcher and one external assessor. The assessment also includes a video recording to analyse the performance afterwards. Only the researcher and one will have access to the video recordings. The videos will be stored on a computer with a secure password. Duplicates will be saved on an external hard drive and will be locked in a cabinet. Both the computer and cabinet are located in an office at the University of the Free State with a secure alarm system. Videos will only be used for this particular study to analyse the child's performance.

LANGUAGE OF EXECUTION

If a child does not understand English or Afrikaans a translator will be used. The researcher will provide the translator.

CONFIDENTIALITY

A code system will be used to ensure confidentiality. No names will be exposed during or after the research, therefore, a number will be allocated to each child.

CONSENT FROM PARENTS/GUARDIANS AND CHILDREN

The parents/guardians will be assigned with a consent form and each child will sign an assent form to participate in the study.

REMUNERATION

The school nor the parents/guardians and/or children will receive any payment for their participation.

VOLUNTARY PARTICIPATION

Participation in the study is voluntary. The school, parents/guardians and children can stop participating in the study at any given point. The school will not be disadvantaged if you decline participating in the research study.

FEEDBACK TO PARENTS/GUARDIANS

The parents/guardians will be provided with a short feedback letter, indicating how the child performed on the ten subtests. If a child at risk is identified, it will be reported on the feedback letter.

PUBLICATION OF RESULTS

The researcher aims to publish the results in a journal and include the findings in training of future occupational therapists.

ETICS

Ethics clearance will be obtained from the Health Science Research Ethics Committee of the University of the Free State before execution of the study.

Thank you for making time to read the information document. For any enquiries or questions regarding the research or procedure, please feel free to contact any of the following people.

Chané Potgieter	Researcher	073 233 4899
Elize Janse van Rensburg	Study Leader	082 840 4080
Health Science Research Ethics Committee		051 405 2812

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HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

Inligtingsdokument –Skole

Konfidensieël

Geagte Hoof

Ek is 'n nagraadse student by die Universiteit van die Vrystaat, met 'n groot belangstelling in kinders.

Die volgende inligting verduidelik my studie.

As arbeidsterapeute evalueer ons kinders om uitdagings in ontwikkeling te identifiseer en sodoende aan te spreek. Een van ons metodes van evaluering is observasies. 'n Organisasie naamlik *South African Institute for Sensory Integration* (SAISI) het 'n Kliniese Observasie assesseringsinstrument, wat arbeidsterapeute gebruik om inligting in te win rakende hoe 'n kind sy sensoriese sisteme gebruik om sekere aksies na te boots wat die terapeut uitvoer. Sensoriese sisteme bestaan onder andere uit die visuele, gehoor en tas sintuie en verskaf inligting aan die brein oor die omgewing en fisiese toestand van die liggaam. Alhoewel hierdie assesseringsinstrument waardevol is, is daar 'n leemte in navorsing oor die wyse en kwaliteit van die kind se aksies wat as tipies en ouderdomstoepaslik beskou word wanneer hy/sy die aksies uitvoer.

DOEL VAN DIE STUDIE

Die doel van die studie is om die wyse waarop kinders tussen die ouderdom van vyf jaar ses maande tot vyf jaar elf maande, skoolgaande in Mangaung Metro, tien aksies van die Kliniese Observasie uitvoer. Die oorsprong van die assesseringsinstrument was in Amerika, daarom benodig ons navorsing op die Suid-Afrikanse populasie, aangesien kinders in Amerika se ontwikkeling kan verskil van kinders wat grootword in Suid-Afrika.

VOORDELE VAN DIE STUDIE

Deelname aan die studie sal bydrae tot nuwe navorsing wat voordelig kan wees vir vroeë identifisering en intervensie van risiko areas in vyf jarige kinders wat skoolgereedheidsvaardighede kan bevorder.

RISIKO VAN DEELNAME

Daar is geen risiko betrokke nie.

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STEEKPROEFPOPULASIE

Beide seuns en dogters tussen die ouerdom vyf jaar ses maande tot vyf jaar elf maande sal ingesluit word in die studie. Die studie beoog ‘n steekproefpopulasie van 120 kinders. Die assessering stop wanneer die voorafbepaalde steekproef behaal is. Dit is dus moontlik dat nie al die kinders wat toestemming gee gaan deelneem aan die studie nie.

DIE VOLGENDE SAL VAN DIE SKOOL VERWAG WORD

- Voorsien ‘n kamer met twee stoele, tafel en ‘n mat waar die assessering kan plaasvind.
- Gee toestemming vir assessering in skooltyd.
- Help in die identifisering van kinders wat aan die insluitingskriteria voldoen.
- Help die navorser in haar proses om toestemmingsbriewe uit te stuur en terug te ontvang.

DIE VOLGENDE SAL VAN DIE KINDERS VERWAG WORD

- Gee instemming en voltooi die instemmingsbrief.
- Deelname aan tien subtoetse van die Kliniese Observasie, dit sluit in onder andere, staan op een been, volg ‘n bewegende objek met die oë, balanseer lyf op ‘n bewegende oppervlak, uitvoering van opeenvolgende vinger-duim aanrakings en staan hande vier voet terwyl die navorser die kind se kop na die kante draai.

ASSESSERING EN VIDEO OPNAME

Die kinders sal gedurende die eerste kwartaal van 2017 (vanaf Januarie – Maart) in skooltyd geëvalueer word, tussen 08:00-13:00 met voorafgaande reëlings met die onderwysers. Die tydsduur van elke kind is 20-30 minute. Elke kind sal individueel deur die navorser en een eksterne assesseerder geassesseer word, dit sluit ‘n video opname in. Die video sal slegs gebruik word vir analisering van die wyse waarop die kind aksies uitvoer en slegs die navorser sal toegang hê tot die videos. Die videos word gestoor op ‘n rekenaar met ‘n beskermde wagwoord. Duplikate word gestoor op ‘n harde skyf wat toegesluit word in ‘n kabinet. Beide die rekenaar en kabinet is in ‘n kantoor op die Universiteit van die Vrystaat se gronde wat beskik oor ‘n alarmstelsel. Videos sal vir geen ander doeleindes as slegs analise vir hierdie navorsingstudie aangewend word nie

TAAL VAN UITVOERING

Indien ‘n kind nie Engels of Afrikaans verstaan nie, sal ‘n tolk gebruik word. Die navorser sal die tolk verskaf.

KOSTE

Daar is geen koste betrokke vir deelname aan die studie nie.

VERTROULIKHEID

‘n Kode lys sal gebruik word om alle inligting verkry konfidensieël te hanteer. Elke kind sal ‘n nommer ontvang en geen name sal gedurende of na die afloop van die studie bekend gemaak word nie.

TOESTEMMING VAN OUERS/VOOGDE EN KINDERS

Toestemmingsbriewe sal aan die ouers/voogde gestuur word en elke kind sal ‘n instemmingsvorms ondertekening vir deelname aan die studie.

VERGOEDING

Die skool, ouers/voogde en/of kinders sal geen vergoeding ontvang vir deelname aan die studie nie.

VRYWILLIGE DEELNAME

Deelname aan die studie is vrywillig. Die skool, ouers/voogde en kinders kan enige tyd gedurende die studie onttrek. Die skool sal nie benadeel word indien u toestemming aan die studie weier nie.

TERUGVOERING AAN OUERS/VOOGDE

Die ouers/voogde sal voorsien word met ‘n verkorte terugvoer brief aangaande die kind se deelname aan die tien items. Indien risiko gevalle geïdentifiseer word sal dit op die terugvoer brief aan die ouers/voogde gekommunikeer word.

PUBLIKASIE VAN RESULTATE

Die navorser beoog om resultate te publiseer in ‘n joernaal en die resultate te gebruik vir opleiding vir toekomstige arbeidsterapeute.

ETIEK

Etiese goedkeuring sal voor die uitvoering van die studie vanaf die Fakulteit Gesondheidswetenskappe se Etiek Komitee verkry word.

Baie dankie dat u tyd geneem het om die inligtingsdokument te lees. Indien u enige vrae oor die navorsingsprojek of prosedure het is u welkom om die volgende persone te kontak:

Chané Potgieter	Navorser	073 233 4899
Elize Janse van Rensburg	Studie leier	082 840 4080
Health Science Research Ethics Committee		051 405 2812

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Consent form - Schools

Confidential

I ____________________________ representative of __________________________ (school) hereby give permission that the children in the school may participate in the research study and that both the school and children will not receive any compensation for participation. I hereby give permission that the researcher and classroom teacher(s) can identify children suitable for the study and I am aware that each individual will be video recorded. Only the researcher will have access to the information and all information will be handled confidentially. I also set aside a room for the researcher for the execution of the research.

Signature: ___________________________

Date: ___________________________

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Toestemmingsbrief - Skole

Konfidensieël

Hiermee gee ek ______________________________, verteenwoordiger van ___________________________ (skool) toestemming dat die leerders van die skool mag deelneem aan die navorsingstudie en dat die skool en/of leerders geen vergoeding sal ontvang nie. Ek gee ook hiermee toestemming dat die navorser en klasonderwyser(es) kinders kan identifiseer vir deelname aan die studie en ek is bewus dat 'n video van individue opgeneem gaan word. Slegs die navorser sseerder sal toegang hê tot die inligting en sal vertroud hanteer word. Ek stel ook hiermee 'n kamer tot die navorser se beskikking vir die uitvoer van die navorsing op die skool se perseel.

Handtekening: ____________________________

Datum: ____________________________

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APPENDIX C

Permission letters to parents/guardians

Information document – Parents/Guardian

Confidential

Dear Parent/Guardian

I am a master's degree student at the University of the Free State, with an interest in children.

The following information will explain my study.

Occupational Therapists assess children to identify developmental difficulties in order to intervene. One of the methods of assessment is observations. An organisation called South African Institute of Sensory Integration (SAISI) has a Clinical Observation assessment tool which is used by Occupational Therapists to gain information about how a child use their sensory systems to engage in the environment through copying actions demonstrated by the therapist. Sensory systems include among others, the visual, sound and touch sense and gives the brain information about the environment and what our body is doing. Even though the document is valuable, there is an absence in research as to what is seen as typical age-related performance of children while engaging in these actions.

GOAL OF THE STUDY

The aim of this study is to describe the performance of children aged five years six months to five years eleven months, from Mangaung Metro pre-schools on ten subtests of the Clinical Observations. As the assessment tool originated from America, research needs to be done on the South African population as children from America might differ from children growing up in South Africa.

BENEFITS OF THE STUDY

Participation in the study will contribute to research which can benefit future identification of risk areas in five-year-old children and can ensure early intervention to assist the child in school readiness.

RISK IN PARTICIPATING

There is no risk involved participating in the research study.

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SAMPLE POPULATION

Both boys and girls aged five years six months to five years eleven months will be included in the study. The study wish to include a sample of 120 children. The researcher will stop assessing children when she acquires her predetermined sample. It is, therefore, possible that your child will not participate in the study even though you give consent.

YOUR CHILD WILL BE ABLE TO PARTICIPATE IN THE STUDY WHEN HE/SHE IS:

- Aged between five years six months and five years eleven months between January and March 2017.

YOUR CHILD WILL NOT BE ABLE TO PARTICIPATE IN THE STUDY WHEN HE/SHE IS:

- Diagnosed with a medical condition/pathology.
- Currently taking medication for diagnosed conditions such as ADHD and epilepsy.
- Diagnosed disability including hearing, visual, physical and cognitive disabilities.
- Previously received occupational therapy, physical therapy and/or speech therapy intervention.

THE FOLLOWING WILL BE EXPECTED FROM YOU

- Complete the questions and sign the attached consent form.
- Return form back to school within 3 days.

THE FOLLOWING WILL BE EXPECTED FROM YOUR CHILD

- Give assent for participation and complete assent form.
- Performing ten subtests of the Clinical Observations, this includes among others, standing on one leg, following an object with their eyes, balancing their body on a moving object, performing sequential thumb-finger touching and kneel stand while researcher turns their head to the sides.

ASSESSMENT AND VIDEO RECORDINGS

The children will be evaluated in the first term of 2017 (from January - March) in school time, from 08:00-13:00 with prior arrangements with the teacher. The duration of the assessment is 20-30 minutes per child. Each child will be assessed individually by the researcher and one external assessor. The assessment also includes a video recording to analyse the performance afterwards. Only the researcher will have access to the video recordings. The videos will be stored on a computer with a secure password. Duplicates will be saved on an external hard drive and will be locked in a cabinet. Both the computer and cabinet are located in an office at the University of the Free State with a secure alarm system. Videos will only be used for this particular study to analyse the child's performance. If you as a parent/guardian would like to be present during your child's evaluation and/or wants a copy of your child's video recording, you are welcome to contact the researcher.

LANGUAGE OF EXECUTION

If your child does not understand English or Afrikaans, a translator will be used. The researcher will provide the translator.

CONFIDENTIALITY

A code system will be used to ensure confidentiality. No names will be exposed during or after the research, therefore, a number will be allocated to your child.

CONSENT FROM PARENTS/GUARDIANS AND CHILDREN

If you give consent your child will be asked to sign an assent form for participating in the researcher.

COSTS

There is no costs involved in participating in the research.

REMUNERATION

You, your child and the school will not receive any payment for participation.

VOLUNTARY PARTICIPATION

Participation in the study is voluntary. You and your child can stop participating in the study at any given point. You and your child will not be disadvantaged if you decline participating in the research study.

FEEDBACK TO PARENTS/GUARDIANS

You will be provided with a short feedback letter, indicating how your child performed. If children at risk is identified, it will be reported on the feedback letter.

PUBLICATION OF RESULTS

The researcher aims to publish the results in a journal and include the findings in training of future occupational therapists.

ETICS

Ethics clearance will be obtained from the Health Science Research Ethics Committee of the University of the Free State before execution of the study.

Thank you for making time to read the information document. For any enquiries or questions regarding the research or procedure please feel free to contact any of the following people.

Chané Potgieter	Researcher	073 233 4899
Elize Janse van Rensburg	Study Leader	082 840 4080
Health Science Research Ethics Committee		051 405 2812

Inligtingsdokument – Ouers/Voogde

Konfidensieël

Geagte Ouer/Voog

Ek is 'n nagraadse student by die Universiteit van die Vrystaat, met 'n groot belangstelling in kinders.

Die volgende inligting verduidelik my studie.

As arbeidsterapeute evalueer ons kinders om uitdagings in ontwikkeling te identifiseer en sodoende aan te spreek. Een van ons metodes van evaluering is observasies. 'n Organisasie naamlik *South African Institute for Sensory Integration* (SAISI) het 'n Kliniese Observasie assesseringsinstrument, wat arbeidsterapeute gebruik om inligting in te win rakende hoe 'n kind sy sensoriese sisteme gebruik om sekere aksies na te boots wat die terapeut uitvoer. Sensoriese sisteme bestaan onder andere uit die visuele, gehoor en tas sintuie en verskaf inligting aan die brein oor die omgewing en fisiese toestand van die liggaam. Alhoewel hierdie assesseringsinstrument waardevol is, is daar 'n gebrek aan navorsing oor die wyse en kwaliteit van die kind se aksies wat as tipies en ouderdomstoepaslik beskou word wanneer hy/sy die aksies uitvoer.

DOEL VAN DIE STUDIE

Die doel van die studie is om die wyse waarop kinders tussen die ouderdom vyf jaar ses maande en vyf jaar elf maande, skoolgaande in Mangaung Metro skole tien aksies van die Kliniese Observasie uitvoer. Die oorsprong van die assesseringsinstrument was in Amerika, daarom benodig ons navorsing op die Suid-Afrikanse populasie, aangesien kinders in Amerika se ontwikkeling kan verskil van kinders wat grootword in Suid-Afrika.

VOORDELE VAN DIE STUDIE

Deelname aan die studie sal bydrae tot nuwe navorsing wat voordelig kan wees vir vroeë identifisering en intervensie van risiko areas in vyf jarige kinders wat skoolgereedheidsvaardighede kan bevorder.

RISIKO VAN DEELNAME

Daar is geen risiko betrokke nie.

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STEEKPROEFPOPULASIE

Beide seuns en dogters tussen die ouerdom vyf jaar ses maande – vyf jaar elf maande sal ingesluit word. Die studie beoog ‘n steekproefpopulasie van 120 kinders. Die assessering stop wanneer die voorafbepaalde steekproef behaal is, dus ontstaan die moontlikheid dat u kind nie gaan deelneem nie.

U KIND SAL KAN DEELNEEM AAN DIE STUDIE AS HY/SY:

- Tussen die ouerdom vyf jaar ses maande en vyf jaar elf maande is tydens Januarie – Maart 2017.

U KIND SAL NIE KAN DEELNEEM AAN DIE STUDIE AS HY/SY:

- Gediagnoseer is met met ‘n mediese kondisie / patologie.
- Tans enige medikasie neem vir ADHD of epilepsie.
- Gediagnoseer met enige gestremdheid naamlik gehoor, visie, fisiese of kognitiewe gestremdheid.
- Voorheen dienste ontvang soos arbeidsterapie, fisioterapie en spraakterapie.

DIE VOLGENDE SAL VAN U VERWAG WORD

- Voltooi en onderteken die aangehegte toestemmingsbrief.
- Stuur dit terug skool toe binne 3 dae.

DIE VOLGENDE SAL VAN DIE KINDERS VERWAG WORD

- Gee instemming en voltooi die instemmingsbrief.
- Deelname aan tien subtoetse van die Kliniese Observasie, dit sluit in onder andere, staan op een been, volg ‘n bewegende objek met die oë, balanseer lyf op ‘n bewegende oppervlak, uitvoering van opeenvolgende vinger-duim aanrakings en staan hande vier voet terwyl die navorser die kind se kop na die kante draai.

ASSESSERING EN VIDEO OPNAME

Die kinders sal gedurende die eerste kwartaal van 2017 (vanaf January – Maart) in skooltyd geëvalueer word, tussen 08:00-13:00 met voorafgaande reëlings met die onderwyser. Die tydsduur van elke kind is 20-30 minute. Elke kind sal individueel deur die navorser en een eksterne assesseerder geassesseer word, dit sluit ‘n video opname in. Die video sal slegs gebruik word vir analisering van die wyse waarop die kind aksies uitvoer en slegs die navorser sal toegang hê tot die videos. Die videos word gestoor op ‘n rekenaar met ‘n beskermde wagwoord. Duplikate word gestoor op ‘n harde skyf wat toegesluit word in ‘n kabinet. Beide die rekenaar en kabinet is in ‘n kantoor op die Universiteit van die Vrystaat se gronde wat beskik oor ‘n alarmstelsel. Videos sal vir geen ander doeleindes as slegs analise vir hierdie navorsingstudie aangewend word nie. Indien u as ouer/voog teenwoordig wil wees tydens u kind se evaluasie en/of ‘n duplikaat van u kind se video wil hê, is u welkom om die navorser te kontak.

TAAL VAN UITVOERING

Indien u kind nie Engels of Afrikaans verstaan nie, sal ‘n tolk gebruik word. Die navorser sal die tolk verskaf.

VERTROULIKHEID

‘n Kode lys sal gebruik word om alle inligting verkry konfidensieël te hanteer. U kind sal ‘n nommer ontvang en geen name sal gedurende of na die afloop van die studie bekend gemaak word nie.

TOESTEMMING VAN OUERS/VOOGDE EN KINDERS

Na u toestemming gegee het sal u kind gevra word om ‘n instemmingsbrief te onderteken waar hy/sy toestemming gee vir deelname aan die studie.

KOSTE

Daar is geen koste betrokke vir deelname aan die studie nie.

VERGOEDING

Die skool, u en u kind sal geen vergoeding ontvang vir deelname aan die studie nie.

VRYWILLIGE DEELNAME

Deelname aan die studie is vrywillig. U en u kind kan enige tyd gedurende die studie onttrek. U en u kind sal nie benadeel word indien u toestemming aan die studie weier nie.

TERUGVOERING AAN OUERS/VOOGDE

U sal voorsien word met ‘n verkorte terugvoer brief aangaande u kind se deelname aan die tien items. Indien risiko gevalle geïdentifiseer word sal dit op die terugvoer brief aan u gekommunikeer word.

PUBLIKASIE VAN RESULTATE

Die navorser beoog om resultate te publiseer in ‘n joernaal en die resultate te gebruik vir opleiding vir toekomstige arbeidsterapeute.

ETIEK

Etiese goedkeuring sal voor die uitvoering van die studie vanaf die Fakulteit Gesondheidswetenskappe se Etiek Komitee verkry word.

Baie dankie dat u tyd geneem het om die inligtingsdokument te lees. Indien u enige vrae oor die navorsingsprojek of prosedure het is u welkom om die volgende persone te kontak:

Chané Potgieter	Navorser	073 233 4899
Elize Janse van Rensburg	Studie leier	082 840 4080
Health Science Research Ethics Committee		051 405 2812

Information Tokomane – Batsoali/Bahlokomeli

Lekunutu

Ratehang Motsoali/Mohlokomedi

Kena ea fumaneng mangolo seithuti se Univesithing ea Naha ea Forestata, ka thahasello e e kholo ea bana ba.

Boitsebiso bo latelang e hlalosa lithuto tsa ka.

Haeba baphekoli mosebetsing hlahloba bana ba rona ho khetholla liphepetso tse ntshetsopele le aterese babolai. E mong oa mekhoa ea rona ea ea hlokometsoeng lekolane. *Institute ya Afrika Borwa Bakeng Kutlo Nyalano* (SAISI) e na le Clinical hlokomela thuto tekolo sesebelisoa mosebetsing ho bokella boitsebiso bo mabapi le kamoo le ngwana sebelisa litsamaiso hae kutlo ho etsisa liketso tse itseng hore phekolang ho romella thepa linaheng. Litsamaiso kutlo ea nang le thuso pono, ho utloa u ame hlaphohetsoe likelellong le ho fana ka boitsebiso bohle ho boko mabapi tikoloho le boema “meleng ea” mele. Le hoja sena se sebelisoa thuto tekolo ke ea bohlokoa, ho na le ho hloka lipatlisiso ka mokgwa le boleng tsa liketso tsa ngwana li nkoa tloaelehileng le “ouderdomstoepaslike” a / o ile a etsa liketso tse.

MORERO OA THUTO EA

Sepheo sa thuto ena ke hoboloka bana ba tseleng ba lilemo li ka lilemo tse hlano le likhoeli tse tseletseng ‘me lilemo tse ka likhoeli tse hlano leshome le motso, sekolong a Mangaung Metro likolo liketso tse leshome tsa clinical hlokomela tswa kantle ho naha. Tsimoloho ea ya tekolo sesebelisoa Amerika, kahoo re lokela ho etsa lipatlisiso ka baahi ba Afrika Borwa, kaha bana ntshetsopeleng Amerika e ka ‘na fapana bana hola mona Afrika Borwa.

MELEMO EA HO ITHUTA KA LINTHO TSE

Ho nka karolo thutong tla tlatsetsa hore a etse lipatlisiso tse ntjha tseo e ka ba molemo bakeng sa ho boitsebahatso mathoasong a lekholo ‘me ho kenella sa libaka ipeha kotsing ea ka selemo bana ba bahlano baholo ba ka ho kgothaletsa fumantsa litsebo tsa sekolo itokisa.

IPEHA KOTSING EA BA HO NKA KAROLO

Ha ho na ipeha kotsing ea ameha.

MEHLALA TSE BAAHI

Ka bobedi bashanyana le banana ba ilemo li ka lilemo tse hlano le likhoeli tse tseletseng – lilemo tse hlano likhoeli leshome le motso tla akarelletsoa thutong. Thuto ea envisions le sampole baahi ba bana 120. Ya tekolo khoatsa ha finyelloa esale pele le sampole ena. Ho ka etsahala hore ngwana oa hao o tla ba le seabo thutong.

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NGWANA OA HAO O TLA BA LE SEABO HO ITHUTA HAEBA A / O ILE BA:

- Ba lilemo li ka lilemo tse hlano le likhoeli tse tseletseng ‘me lilemo tse ka likhoeli tse hlano leshome le motso nakong ya Pherekgong - Hlakubele 2017.

NGWANA OA HAO O TLA BA SA KOPANELE THUTONG HAEBA A / O ILE A:

- Na le boloetse ba ka phekolo ea meriana boemo / bolwetse.
- Hong joale, meriana leha e le efe bakeng sa ADHD kapa lefu la sethoathoa.
- Fumanoa ba nang le bokooa leha o le efe e utloa, pono ‘meleng kapa dikopanothutano o holofetse.
- Tse neng ile a fumana litsebeletso tse kang tsa phekolo mosebetsing, physiotherapie ke phekolo puo.

BOITSEBISO BO LATELANG HO TLA HLOKEHA

- Tlatsa le ho saena khomaretse tumello sebopeho se setle.
- E romella sekolong ka mora matsatsi tsa di 3.

LATELANG E TLA KA LEBELLOA TSA BANA

- Fa tumello le tlatsa lengolo la tumellano.
- Ho nka karolo ka subtests leshome tsa hlokomela Clinical, sena se alarelletsa, ha a ba bang, ema leoto le mong, latela ntho e hahabang le mahlong a bona, lekalekanya mele leqepheng la bokaholimo falla, a phethang tse latellang monoana o motona – thopothela le eme ditlhopa tsa bone tshole ha a ntse a mofuputsi reteleha hlooho ea ngwana oa ka lehlakoreng la.

REKOTA TEKOLO LE VIDEO E

Bana, nakong ea etsang kotara ea pele ka 2017 (ho thla Pherekgong – Hlakubele) e hlahlojoa lihoreng sekolong hotloha 08:00 – 13:00 le litlhophiso tse hlokahalang pele le titjhere eo. Ke nako ea e mong le ngwana metsotso 20 –30. Ngwana ka mong o tla le batho ka bomong dirwa ditekolo ke lefokisi le e assessor ntle, ho akarelletsa le ho rekota e video. Video tla feela ka sebediswa bakeng sa ho hlahloba tsela eo ngwana eo mesbetsi e mpa feela e le mofuputsi le setsebi sa assessor Link tla ba khona ho fumana boitsebiso livideo. Livideo li boloketsoe khomputareng le phasewete sireletsoa. Wa kana li boloketsoe ka la tiske ya ka thata e notletsoe a rarolleha ka raka e. Ka bobedi PC le raka a sebelisoa e le ofisi Univesithing ea mobu ke Muso li Free na lialamo. Videos tla sebelisoa bakeng sa ho se merero e meng ho feta Analysis feela baking sa thuto ea sena. Haeba wena joaloka motsoali, ho ba teng fa sethopha se kopane moo ngwana oa hao e hlahlojoa le / kapa kopi ea videotaped ngwana ao hao ba batla hore u ke omohelehile ho iteanya le mofuputsi eo.

PUO EA POLAO

Haebo ngwana hao ha utllwisisi Senyesemane kapa Seburu, otia sebedisa di toloko. Mohlahlobi otla elsa ditoloko.

LEKUNUTU

Lenaneo la kode letla Sebediswa ho tholahatsa ho tshwara boitshebiso bo lekunutung.

RUMELO YA BATSWADI/MOHLOKOMEDI LE BANA

Ha motswadi a fana ka tumello otla kopa ngwana hao a fane ka lengolo ia tumello hare motswadi a tshwaye fatshe moo atla fana ka tumello ya karole ya ho ithuta.

DITJEHO

Ha ho na litsenyehelo amehang bakeng sa ho nka karolo thutong.

PUSELETSO

Sekolong, o le ngwana oa hao tla fumana ho se na puseletso bakeng sa ho nka karolo thutong.

HO NKA KAROLO EA BOITHATELO

Ho nka karolo thutong e boithatelo. Wena le ngwana oa hao ka hula ka nako leha e le efe nakong ea thuto. Wena le ngwana oa hao o ke ke a ntsoa kotsi haeba o hana tumello ea ho ithuta.

DITSHWAELO BATSOALI / BAHHLOKOMELI

O tla fuwa nang le e khutsoanyane karabelo lengolo mabapi le ho nka karolo ea ngwana oa hao a decathlon eo. Haeba linyeoe tse kenyang kotsing ba khetholloa tla buisana ka eona ho wena ka ditshwaelo lengolo.

HATISOE LA DITHOLWANA

Bafuputsi ba rera ho hatisa liphello tse koranteng e le ho sebedisa liphello bakeng sa koetliso ka bokamoso baphekoli mosebetsing.

ETHICS

Ho amoheloa ke boitshwaro tla fumana bakeng sa ho kenya tshebetsong ea thuto ho tloha Faculty la Bophelo Science Ethics Komiti.

Haeba o na le lipotso mabapi le morero etsa lipatlisiso kapa Tsamaiso e ho lokile ho iteanya le batho ba latelang:

Chané Potgieter	Mofuputsi	073 233 4899
Elize Janse van Rensburg	Moeta-pele oa thuto ea	082 840 4080
Health Science Komiti etsa Lipatlisiso	*Ethics*	051 405 2812

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Consent form – Parent(s) / Guardian(s)

Confidential

I ____________________ parent / guardian of _____________________ (child) give permission for participation in the research study. I am aware that the information will be handled confidentially and that neither I nor my child will receive any compensation for participating in the research. I am aware and give consent that my child can be video recorded. I am aware that a feedback letter with my child's performance on the ten subtests of the clinical observation will be sent to me. I am aware that my child will not receive any treatment during or after participating in the study.

Please answer the following questions with regards to your child.

1. Child's date of birth: _____________________________
2. Child's age (year and month): _____________________
3. Has your child received any therapy (occupational therapy, speech therapy, physiotherapy etc.) Yes ☐ / No ☐
   If yes, which type of therapy and why? _______________________________
   ____
4. Is your child taking any medication at the moment? Yes ☐ / No ☐
   If yes, which type of medication and why? _________________________
   ____
5. Has your child been diagnosed with any condition(s)? Yes ☐ / No ☐
   If yes, which type of condition and whom diagnosed your child? ___________
   ____

Parent/Guardian Signature: __________________________

Date: __________________________

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Toestemmingsvorm – Ouers/Voogde

Konfidensieël

Hiermee gee ek ______________________________, ouer/voog van ________________________ (kind) toestemming vir deelname aan die navorsingstudie. Ek is bewus dat die inligting vertroulik hanteer sal word en dat ek en/of my kind nie vergoeding vir deelname aan die studie sal ontvang nie. Ek is bewus en gee toestemming dat 'n video opname gemaak gaan word. Ek is bewus dat 'n terugvoer brief aangaande my kind se deelname aan die tien subtoetse van die kliniese observasies gegee gaan word. Ek is bewus dat my kind geen terapie dienste tydens of na deelname aan die studie gaan ontvang nie.

Beantwoord asseblief die volgende vrae aangaande u kind.

1. Kind se geboorte datum: ________________________________
2. Kind se ouderdom (jaar en maand): ______________________
3. Het u kind al voorheen enige terapie dienste ontvang (arbeidsterapie, spraak terapie, fisioterapie ens.) Ja ☐ / Nee ☐
   Indien Ja, watter tipe terapie en die rede daarvoor? ______________________
   ____
4. Neem u kind tans medikasie? Ja ☐ / Nee ☐
   Indien Ja, watter tipe medikasie en die rede daarvoor? ___________________
   ____
5. Is u kind gediagnoseer met enige kondisie(s)? Ja ☐ / Nee ☐
   Indien Ja, watter tipe kondisie en wie het u kind gediagnoseer? ___________
   ____

Ouer/ Voog Handtekening: ____________________________

Datum: ____________________________

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Tumello sebopeho sefe – Batsoali / Bahlokomeli

LEKUNUTU

Ke tsenngwa jaana ________________________________, batsoali/bahlokomeli ea

________________________________ (ngwana) a lumela nna le seabe mo thuto. Kea hlokomela hore boitsebiso bo tla na lekunutu le hore ngwana oa ka puseletso bakeng sa ho nka karolo ke le/kapa ba ke ke ba thutong. Kea hlokomela le lumela hore le mantsoe a rekotiloeng tsa video ha etsoa. Video ke ke ha nehelanoa ho na joaloka motsoali / mohlokomeli. Kea hlokomela hore karabelo lengolo mabapi le ho nka karolo ngwana oa ka o tla fuoa ho subtests leshome tsa lemohileng litleleniki tla fuoa. Kea hlokomela hore nkwana oa ka ho sa ditshebeletso phekolo nakong kapa ba tla fumana bakeng sa ho kopanela thutong.

Ka kopo araba lipotso tse latelang mabapi le ngwana oa hao.

1. Letsatsi tsoalo ea ngwana oa: __________________________________
2. Dilemo ngwana (selemo le khoeli): ______________________________
3. E ngwana oa hao neng ile a fumana ditshebeletso dife kapa dife phekolo (phekolo mosebetsing, phekolo puo, ea physiotherapy jj. Ee _____ / Ha ho _____ Haeba ho jaolo, ke eng mofuta oa phekolo le lebaka la seo? ____
4. Nka ngwana oa hao hodimo meriana? Ee ____ / Ha ho ____

Haeba ho joalo, le ea mofuta ofe meriana le lebaka la seo? __________________________________

5. E ngwana oa hao fumanoa le boemo leha e le efe(s)? Ee ____ / Ha ho ____

Haeba ho joalo, le ea mofuta le ea fumanoa ngwana oa hao? __________________________________

Tshaeno wa Mosali / Hlokomeli: ________________________________

Letsatsi: ________________________________

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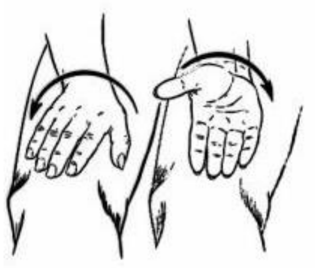
APPENDIX D

Permission letters to participants

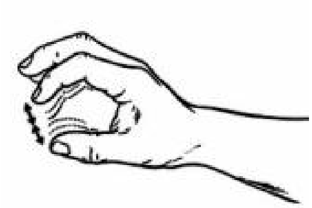
Assent form - Child

Today we are going to do some tasks. We are going to do ten tasks. I am going to make a video of you which I will watch later again. You can stop at any time if you don't want to play anymore. We are going to see if you can do the following:

1) Move your arms on your legs

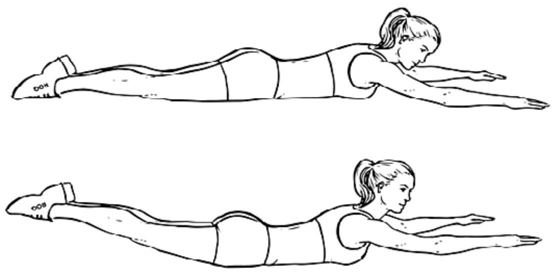


2) Touch your fingers



3) Stay on a moving ship

4) Lie on your tummy and lift your arms



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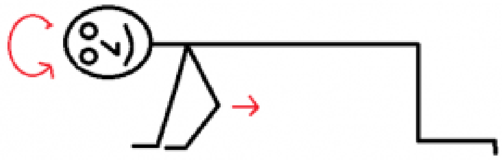
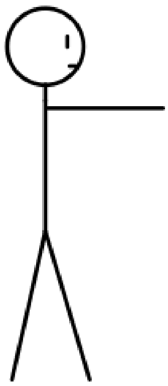
5) Move your head while you stand like a doggy



6) Lie on your back and lift up your legs

7) Stay standing while I move your head



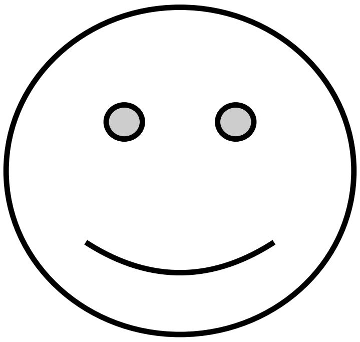
8) Touch your nose

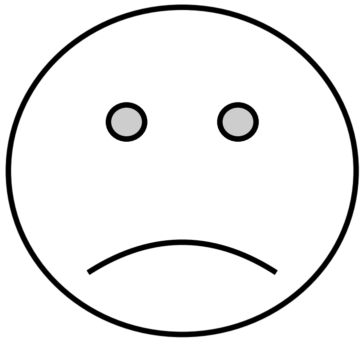
9) Follow a moving object with your eyes

10) Stand on one leg

Will you play with me?

I ______________________________________ (child's name) will play along and don't mind that I am video recorded.





Mark the face you choose with an X.

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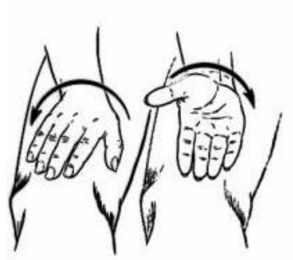
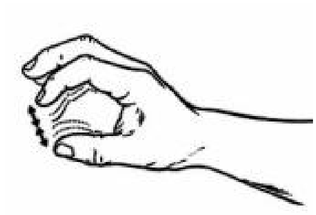
Instemmingsbrief - Kind

Vandag gaan ons ‘n paar takies doen. Ons gaan tien takies doen. Ek gaan jou afneem terwyl ons dit doen, dan kan ek weer daarna kyk as ons klaar is. Jy kan enige tyd stop as jy nie meer saam my wil speel nie. Ons gaan kyk of jy die volgende kan doen:

1) Beweeg jou arms op jou bene

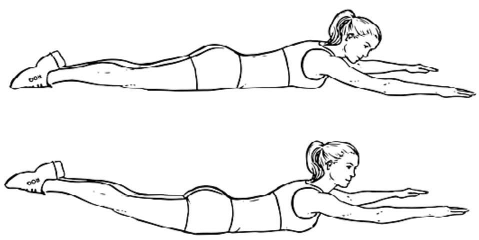


2) Raak aan jou vingers



3) Bly op ‘n skip sonder om af te val

4) Hoe lank kan jy op jou magie lê en jou arms optel



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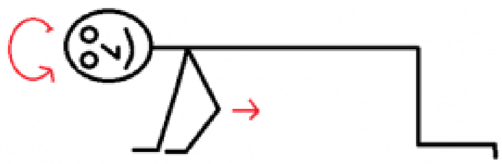
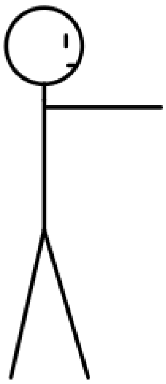
5) Draai jou kop terwyl jy soos 'n hondjie staan



6) Hoe lank kan jy in 'n balletjie lê op die vloer

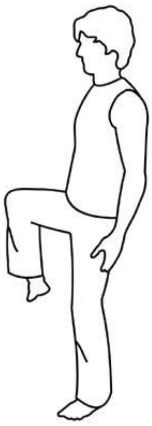
7) Bly staan terwyl ek jou koppie draai



8) Raak aan jou neus

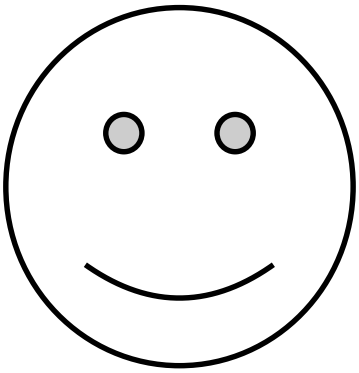
9) Volg ‘n mannetjie wat beweeg met jou ogies

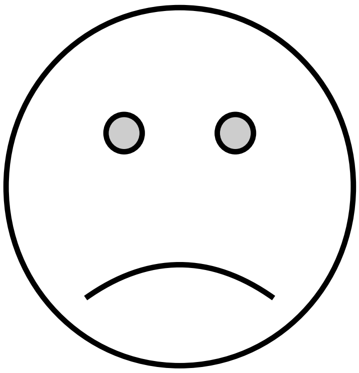
10) Staan op een been



Sal jy saam my speel?

Ek ________________________________ (kind se naam) sal saam speel en gee nie om dat ‘n video opname van my gemaak word nie.





Merk die gesiggie wat jy kies met ‘n X.

APPENDIX E

Permission letter to translator

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Information document - Translator

Confidential

Dear Translator

I am a master's degree student at the University of the Free State, with an interest in children.

The following information will explain my study.

Occupational Therapists assess children to identify developmental difficulties in order to intervene. One of the methods of assessment is observations. An organisation called South African Institute of Sensory Integration (SAISI) has a Clinical Observation assessment tool which is used by Occupational Therapists to gain information about how a child use their sensory systems to engage in the environment through copying actions demonstrated by the therapist. Sensory systems include among others, the visual, sound and touch sense and gives the brain information about the environment and what our body is doing. Even though the document is valuable, there is an absence in research as to what is seen as typical age related performance of children while engaging in these actions.

GOAL OF THE STUDY

The aim of this study is to desribe the performance of children aged five years six months to five years eleven months, from Mangang Metro pre-schools on ten subtests of the Clinical Observations. As the assessment tool originated from America, research needs to be done on the South African population as children from America might differ from children growing up in South Africa.

BENEFITS OF THE STUDY

Participation in the study will contribute to research which can benefit future identification of risk areas in five-year-old children and can ensure early intervention to assist the child in school readiness.

RISK IN PARTICIPATING

There is no risk involved in translating instructions.

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SAMPLE POPULATION

Both boys and girls aged five years six months – five years eleven months will be included in the study. The study wish to include a sample of 120 children.

THE FOLLOWING WILL BE EXPECTED FROM YOU

- The researcher will make use of your services only when the children is unable to understand Afrikaans or English.
- Complete the attached consent form.
- You will be trained by the researcher.
- Assist in translating exact instructions.
- Assist in translating questions the child may have.
- Be present for the full duration of the child's assessment.

THE FOLLOWING WILL BE EXPECTED FROM THE CHILDREN

- Give assent for participation and complete assent form.
- Performing ten subtests of the Clinical Observations, this include among others, standing on one leg, following an object with their eyes, balancing their body on a moving object, performing sequential thumb-finger touching and kneel stand while researcher turns their head to the sides.

ASSESSMENT AND VIDEO RECORDINGS

The children will be evaluated in the first term of 2017 (from January to March) in school time, from 08:00-13:00 with prior arrangements with the teacher. The duration of the assessment is 20-30 minutes per child. Each child will be assessed individually by the researcher and one external assessor. The assessment also includes a video recording to analyse the performance afterwards. It is, therefore, possible that you might also be video recorded. Only the researcher will have access to the video recordings. The videos will be stored on a computer with a secure password. Duplicates will be saved on an external hard drive and will be locked in a cabinet. Both the computer and cabinet are located in an office at the University of the Free State with a secure alarm system. Videos will only be used for this particular study to analyse the child's performance.

COSTS

There is no costs involved in translating.

REMUNERATION

You will not receive payment for your translating services.

VOLUNTARY PARTICIPATION

Assisting the researcher is voluntary and you can withdraw from your role as translator at any given point. You will not be disadvantaged if you decline your role as translator.

PUBLICATION OF RESULTS

The researcher aims to publish the results in a journal and include the findings in training of future occupational therapists.

ETICS

Ethics clearance will be obtained from the Health Science Research Ethics Committee of the University of the Free State before execution of the study.

Thank you for making time to read the information document. For any enquiries or questions regarding the research or procedure please feel free to contact any of the following people.

Chané Potgieter	Researcher	073 233 4899
Elize Janse van Rensburg	Study Leader	082 840 4080
Health Science Research Ethics Committee		051 405 2812

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Consent form – Translator

Confidential

I ______________________________ (name) hereby agree to take in the role as a translator. I will repeat instructions exactly as the researcher asks and will assist in translating questions that the child may have. I pledge to keep the information that I see during the research confidential. I understand that I will not receive compensation for my services rendered. I am aware that I might appear on the video recordings.

Signature: ___________________________

Date: ___________________________

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APPENDIX F

Testing list

List of participants per school

School name: SES: Middle-high / Low

Childs nr:	**Childs name:**	**DOB:**	**Gender:**	**Age:**	**Test Feb**	**Test March**	**Class room nr**
Total Boys:			**Total Girls:**				

APPENDIX G

New measuring instrument

Number of child:	**DOB:** 20 / /	**Gender:** M_1 / F_2	**SES:** H_1 / L_2	**Date of test:** 2017 / /	**Dominance:** R_1 / L_2

1	2	3	4.	5.
Unable to perform	Makes an attempt but only achieves partially	Able to perform, poor control/not well integrated	Good, slight inconsistencies/lacks some integration	Execute with ease / good control / well integrated /

TEST	GRADE	COMMENTS	PERFORMANCE CHECKLIST: OBSERVABLE CHARACTERISTICS					
DIADOKOKINESIS								
Right (____) times	5 4 3 2 1		**SH PARAMETERS**	**R**	**L**	**B**		
Left (____) times	5 4 3 2 1		Start position	P_1 S_2	P_1 S_2	P_1 S_2		**DDK 1**
Both (____) times	5 4 3 2 1		Isolated forearm movements					**DDK 2**
			Position of thumb next to index finger					**DDK 3**
			Rhythmical movement					**DDK 4**
			SNH PARAMETERS					
			Inco-ordination					**DDK 5**
			Associated reactions with mouth					**DDK 6**
			Associated reactions with other hand					**DDK 7**
			Fixation of upper arm					**DDK 8**
			Rigid body					**DDK9**
			Shoulder elevation					**DDK10**
			Use vision					**DDK11**
			Slaps hard on legs					**DDK12**
			Unusual movement of fingers					**DDK13**
			Sloppy movement					**DDK14**
			Extreme caution in movement					**DDK15**
			Double tap					**DDK16**
			Press elbow against body					**DDK 17**
			Absence of supination (dorsal side of hand hits leg partially)					**DDK18**
			Hands not flat (c-curved)					**DDK19**
			Rolling forearm on leg					**DDK20**
Thumb-finger touching								
Right	5 4 3 2 1		**SH PARAMETERS**	**R**	**L**	**B**	**No vision**	
Left	5 4 3 2 1		Thumb opposition					**TFT 1**
Both	5 4 3 2 1		Touch fingers with tip of thumb					**TFT 2**
			Double tap on 5th finger					**TFT 3**
			Isolated finger movements					**TFT 4**
Vision occluded	5 4 3 2 1		Correct sequence touching fingers 2-5 and back					**TFT 5**
			Good timing					**TFT 6**
			SNH PARAMETERS					
			Starting position (taps on any other finger but index)					**TFT 7**
			Restart pattern					**TFT 8**

			Lose sequence when returning from 5th finger					**TFT 9**
			Slow movement					**TFT 10**
			Sloppy movement					**TFT 11**
			Associated reactions with mouth					**TFT 12**
			Associated reactions with opposite hand					**TFT 13**
			Reliance on visual input					**TFT 14**
			Tactile input (slide finger)					**TFT 15**
			Proprioceptive input (press hard)					**TFT 16**
			First perform action with one hand then the other					**TFT 17**
			Restart same forward sequence					**TFT 18**
			Double tap each finger (2-5)					**TFT19**
			Correct pattern but performs in reverse (5th-1st finger)					**TFT20**
Equilibrium								
Prone	5 4 3 2 1		**SH PARAMETERS**	**Prone**	**Quad**	**Kneel**	**LSit**	
Quadruped	5 4 3 2 1		Trunk rotation					**ER 1**
Upright kneeling	5 4 3 2 1		Elongation of weight bearing side					**ER 2**
Long sitting	5 4 3 2 1		Flexion of non-weight bearing side					**ER 3**
			Weight shift					**ER 4**
			Fluid response					**ER 5**
			SNH PARAMETERS					
			Relies on protective extension					**ER 6**
			Rigid response					**ER 7**
			Widen base of support					**ER 8**
			Lower centre of mass					**ER 9**
			Holds onto equilibrium board					**ER 10**
			Lordosis and and anterior tilt of pelvis					**ER 11**
			Arm abduction less than 45°					**ER12**
			Arm abduction more than 45°					**ER13**
			Fixate arms against body					**ER14**
			Associated reaction with mouth					**ER15**
			C-curve in upper trunk (shoulder and back)					**ER16**
			Grasps onto clothes or body with hands					**ER17**
			Press or lock feet together					**ER18**

Prone Extension Posture						
Full PEP ______ sec	5 4 3 2 1		**SH PARAMETERS**			
Bent legs ______ sec	5 4 3 2 1		Lifts limbs simultaneously			**PE1**
Arms only _____ sec	5 4 3 2 1		Head vertical ≥ 45°			**PE2**
			Head held steady			**PE3**
			Arch in upper trunk			**PE4**
			Elbows with or behind shoulders			**PE5**
			Thighs off mat, from mid-thigh distally			**PE6**
			Knees bent (45° or less)			**PE7**
			SNH PARAMETERS			
			Assumes posture segmented	UL 1st / LL 1st		**PE8**
			Head raised less than 45°			**PE9**
			Back appears flat or minimally arched			**PE10**
			Elbows forward of shoulders			**PE11**
			Thighs barely off mat, paper can be slid under knee, not much above			**PE12**
			Definite flexed knees (more than 50°)			**PE13**
			Excessive effort required to maintain posture			**PE14**
			Unable to count out loud			**PE15**
			Fixation of body			**PE16**
			Rocking body			**PE17**
			Asymmetry between sides			**PE18**
			Elevation of shoulder			**PE19**
			Unable to lift knees off the ground			**PE20**
			Stabilise legs placing one foot over another			**PE21**
			Associated reactions with mouth			**PE22**

Asymmetrical Tonic Neck Reflex								
Quad position Degrees R arm ___° Degrees L arm ___°	5 4 3 2 1		**SH PARAMETERS**	**Head turn R**	**Head turn L**	**TIP head turn R**	**TIP head turn L**	
Reflex Inhibiting Posture			No changes in joint position					**ATNR1**
Head turned R ___ sec	5 4 3 2 1		Elbow flexion present but less than 25°					**ATNR2**
Head turned L ___ sec	5 4 3 2 1		Head held steady					**ATNR3**
			Able to assume posture fluently					**ATNR4**
			Able to keep chin against shoulder					**ATNR5**
			Straight back					**ATNR6**
			Leg and knee in line with hip (90°)					**ATNR7**
			Straight leg (0-45°)					**ATNR8**
			Head in line with back					**ATNR9**
			SNH PARAMETERS					

	Elbow flexion of contralateral arm					ATNR10
	Resistance to head turn					ATNR11
	Tends to lock elbows					ATNR12
	Tend to open shoulder and turn body					ATNR13
	C-curve in back and shoulders					ATNR14
	Excessive ordosis of back					ATNR15
	Retracts chin in body					ATNR16
	Body sway					ATNR17
	Associated reactions with mouth					ATNR18

Symmetrical Tonic Neck Reflex

Degrees R arm ____° Degrees L arm ____°	5 4 3 2 1	**SH PARAMETERS**	**NECK FLEXED**	**NECK EXTEND**	
		No changes in joint position of arms			**STNR1**
		SNH PARAMETERS			
		Elbow flexion more than 25°			**STNR2**
		Posterior pelvic tilt			**STNR3**
		Rounded / arched back			**STNR4**
		Excessive extension of elbows			**STNR5**
		Anterior pelvic tilt			**STNR6**
		Lordosis of back			**STNR7**
		Tends to lock elbows			**STNR8**
		Resistant to head turning			**STNR9**

Supine Flexion Posture

_____Seconds	5 4 3 2 1	**SH PARAMETERS**		
		Lifts limbs simultaneously		**SF1**
		Neck flexion ≥ 45°		**SF2**
		Head held steady		**SF3**
		C-curve in upper trunk (shoulder and back)		**SF4**
		Can keep legs and neck against resistance		**SF5**
		SNH PARAMETERS		
		Assumes posture segmented	UL 1st / LL 1st	**SF6**
		Chin lead		**SF7**
		Retracts chin in body		**SF8**
		Neck flexion less than 45°		**SF9**
		Trunk and shoulders in line (no definite curve present)		**SF10**
		Effort required		**SF11**
		Head lag before 10 seconds		**SF12**
		Unable to count aloud		**SF13**
		Fixation of UL		**SF14**
		Fixation of LL		**SF15**
		Fisting of hands		**SF16**
		Grabbing onto clothes		**SF17**

	Press feet together				SF18
	Placing one foot over the other				SF19
	Shoulder elevation				SF20
	Associated reaction with mouth				SF21

Schilder's Arm Extension

5 4 3 2 1	**SH PARAMETERS**	**Static(counting)**	**Head turned**	
	No changes in upper limbs			**SAE1**
	Dissociate head from trunk			**SAE2**
	Maintains balance when eyes are closed			**SAE3**
	SNH PARAMETERS	**Static (counting)**	**Head turned**	
	Starting position of arms more than 90°	R_1 L_2 B_3	R_1 L_2 B_3	**SAE4**
	Starting position of arms less than 90°	R_1 L_2 B_3	R_1 L_2 B_3	**SAE5**
	Arms drop less than 45° (from neutral 90° position)	R_1 L_2 B_3	R_1 L_2 B_3	**SAE6**
	Arms drop more than 45° (from neutral 90° position)	R_1 L_2 B_3	R_1 L_2 B_3	**SAE7**
	Arms raised less than 45° (from neutral 90° position)	R_1 L_2 B_3	R_1 L_2 B_3	**SAE8**
	Arms raised more than 45° (from neutral 90° position)	R_1 L_2 B_3	R_1 L_2 B_3	**SAE9**
	Spoon hands	R_1 L_2 B_3	R_1 L_2 B_3	**SAE10**
	Touching hands to stabilise arms			**SAE11**
	Able to correct positioning of upper arms	R_1 L_2 B_3	R_1 L_2 B_3	**SAE12**
	Involuntary movements of fingers			**SAE13**
	Dislike having eyes closed			**SAE14**
	Fixation of arms			**SAE15**
	Elevation of shoulders			**SAE16**
	No opening between fingers (1-4)			**SAE17**
	Asymmetry (one hand lower than other) mark which is lower	**R_1 L_2**	**R_1 L_2**	**SAE18**
	Arms separate			**SAE19**
	Resistant to head turning			**SAE20**
	Flexion of elbows	R_1 L_2 B_3	R_1 L_2 B_3	**SAE21**
	Thumb to palm not next to index finger	R_1 L_2 B_3	R_1 L_2 B_3	**SAE22**
	Trunk rotation		More than 45°_1 Less than 45°_2	**SAE23**
	Horizontal deviation of the arms > 45°			**SAE24**
	Retracts chin in body			**SAE25**
	Associated reactions with mouth			**SAE26**
	Hand drop	R_1 L_2 B_3	R_1 L_2 B_3	**SAE27**

Finger-To-Nose					
	5 4 3 2 1		**SH PARAMETERS**	**R**	**L**	
			Fluid and smooth movement			**FtN1**
			Touch tip of nose within 1.5 cm			**FtN2**
			Arms abducted 90°			**FtN3**
			Miss tip of nose, able to correct			**FtN4**
			SNH PARAMETERS	**R**	**L**	
			Turn head to the sides while touching nose			**FtN5**
			Non touching arm flexed 45° or more			**FtN6**
			Poor rhythm			**FtN7**
			Loses rhythm			**FtN8**
			Touch nose not with tip of finger			**FtN9**
			Retracts chin			**FtN10**
			Associated reactions with mouth			**FtN11**
			Press hard on nose			**FtN12**
			Replace finger with opposite hand			**FtN13**
			Fixate upper limbs			**FtN14**

Gaze Stability						
	5 4 3 2 1		**SH PARAMETERS**	**Head vertical**	**Head horizontal**	
			Stable gaze when head moves			**GS1**
			Eye movement independent from head movement			**GS2**
			Smooth bilateral coordination of eyes			**GS3**
			Smooth movement of head			**GS4**
			SNH PARAMETERS			
			Associated reactions with the mouth			**GS5**
			Lose eye contact when object is in peripheral vision			**GS6**
			Uncoordinated action			**GS 7**
			Slow movement			**GS8**
			Over-exaggerated movement of head			**GS9**
			Fixation of upper limbs			**GS10**
			Don't move head through full ROM			**GS11**

Standing Balance								
				Eyes open		Eyes closed		
Eyes open			**SH PARAMETERS**	**R leg**	**L leg**	**R leg**	**L leg**	
R leg ____ sec	5 4 3 2 1		Maintain arms in sides					**SB1**
L leg ____ sec	5 4 3 2 1		**SNH PARAMETERS**					
Eyes closed			Body sway					**SB2**
R leg ____ sec	5 4 3 2 1		Asymmetry					**SB3**
L leg ____ sec	5 4 3 2 1		Bracing against leg					**SB4**
			Use vision to look at feet					**SB5**
			Eyes or head not steady					**SB6**
			Shift supporting foot					**SB7**
			Exaggerated movements of arms and trunk					**SB8**
			Toe and ankle movement without displacing the feet					**SB9**
			Anterior tilt of pelvis					**SB10**
			Grabs onto clothes					**SB11**
			Associated reactions with mouth					**SB12**
			Shoulder elevation					**SB13**
			Fixating body					**SB14**

APPENDIX H

First draft – measuring instrument

Number of child:		**Date:**	
Gender:	Boy | Girl	**DOB:**	

The following scale will be used

1	2	3	4.	5.
Unable to perform	Makes an attempt but only achieves partially	Able to perform, poor control/not well integrated	Good, slight inconsistencies/lacks some integration	Execute with ease / good control / well integrated /

			PERFORMANCE CHECKLIST	
TEST	**GRADE**	**COMMENTS**	**OBSERVABLE CHARACTERISTICS**	**MEASURABLE CHARACTERISTICS**
Diadokokinesis				
Right (____) times	5 4 3 2 1		☐ Inco-ordination ☐ Associated reaction with mouth ☐ Associated reactions with other hand ☐ Symmetry (thumb position) ☐ Total arm rotation ☐ Isolated forearm movements ☐ Fixation of upper arm ☐ Rigid body ☐ Use vision	☐ Less than 4 patterns in 10 seconds ☐ 4 Patterns in 10 seconds ☐ More than 4 patterns in 10 seconds
Left (____) times	5 4 3 2 1			
Both (____) times	5 4 3 2 1			

			☐ Slapping hard on legs ☐ Large movements ☐ Unusual movement of fingers ☐ Careless movements ☐ Extreme caution in movements ☐ Double tap/bounce	
Thumb-Finger Touching				
Right	5 4 3 2 1		☐ Speed ☐ Fine motor co-ordination ☐ Timing and sequencing ☐ Right-left differences ☐ Associated reactions with mouth ☐ Associated reactions with opposite hand or limbs ☐ Mirror movements ☐ Visual input ☐ Tactile input (slide finger) ☐ Proprioceptive input (hard) ☐ Double tap on little finger ☐ Move fingers independently from rest of hand ☐ Is it a practised skill?	☐ Can't perform action ☐ Performs action without double touch ☐ Performs action with double touch
Left	5 4 3 2 1			
Both	5 4 3 2 1			

Equilibrium				
Prone	5 4 3 2 1		☐ Amount of trunk rotation ☐ Elongation of weight bearing side ☐ Flexion of non-weight bearing side ☐ Degree to which equilibrium is used before PE is elicited ☐ Relies solely on PE ☐ Fluid response ☐ Rigid response ☐ Widen base of support ☐ Holds onto equilibrium board ☐ Lordosis and pushing out buttox in half kneeling	☐ Protective response elicited with 0-15° tilt in kneel and stand position ☐ Protective response elicited with more than 15° tilt in kneel and stand position
Quadruped	5 4 3 2 1			
Long sitting	5 4 3 2 1			
Upright kneeling	5 4 3 2 1			
Prone Extension				
______Seconds	5 4 3 2 1		☐ Effort required ☐ Count out loud ☐ Fixation of body ☐ Rocking body ☐ Asymmetry between sides ☐ Assume posture fluent ☐ Assume posture first with head/neck then with the other ☐ Elevation of the shoulder	☐ Holds head only position for less than 15 seconds ☐ Holds head only position for 15-20 seconds ☐ Holds head only position for more than 20 seconds

			☐ Can child sustain the extension ☐ Can only lift up legs	
Asymmetrical tonic neck reflex				
Quad position Degs R L	5 4 3 2 1		☐ Elbow flexion of contra lateral arm ☐ Extension of leg on face side ☐ Resistance to head turning ☐ Differences in response when head is turned to the left and right ☐ Low tone ☐ Mass patterns ☐ General posture ☐ Proximal stability in four-point kneeling	☐ Elbow flexion less than 25° ☐ Elbow flexion about 25° ☐ Elbow flexion more than 25°
Reflex inhibiting position Hold for ____ seconds	5 4 3 2 1			☐ Can assume posture and maintain for several seconds ☐ Can assume posture only with great difficulty ☐ Cannot assume posture
Symmetrical tonic neck reflex				
Degs R L	5 4 3 2 1		☐ Elbow flexion when neck if flexed ☐ Changes in pelvic tilt and trunk rotation ☐ Mass flexion of lower limbs ☐ Neck flexed: posterior pelvic tilt ☐ Neck extend: anterior pelvic tilt	☐ No changes in joint position ☐ Slight changes in joint position ☐ Definite changes in joint position

Supine Flexion Posture				
______Seconds	5 4 3 2 1		☐ Assume posture smoothly ☐ Effort required ☐ Neck retraction or true neck flexion ☐ Lifts limbs simultaneously ☐ Lifts arms then legs or vice versa ☐ Maintain stable posture ☐ Head lack ☐ Counts aloud ☐ Can keep posture against resistance	☐ Holds to 20 seconds with moderate exertion and slight resistance ☐ Holds to 10 seconds: To 20 seconds with great exertion ; or unable to hold against resistance ☐ Unable to hold or holds for 0-9 seconds
Schilder's arm extension				
Involuntary movement	5 4 3 2 1		☐ Can head be easily moved ☐ Tremors of hands and fingers ☐ Shoulder stability ☐ Involuntary movements of the fingers ☐ Dis-inhibition of the arms ☐ Left-right differences ☐ Resistance to head turning ☐ Dissociate head from trunk ☐ Difference in response between open and closed eyes ☐ Discomfort on head turning	☐ Normal ☐ Slight ☐ Definite ☐ Trunk rotation more than 45° when head is turned 90° ☐ Trunk rotation less than 45° when head is turned 90°
Postural changes	5 4 3 2 1			
Trunk rotation	5 4 3 2 1			

			☐ Involuntary movements in fingers, tongue, limbs or head ☐ Dislike having eyes closed	
Finger to nose				
Right cm			☐ Fluidity and smoothness of movement ☐ Left-right differences ☐ Associated movement of the head and trunk ☐ Associated movements of the mouth ☐ Symmetry ☐ Posture ☐ Rhythm of movement	☐ Touch within 1 cm of the tip of the nose ☐ Touch within more than 1 cm of the tip of the nose
Left cm				
Able to correct	Yes No			
Gaze stability				
Head vertical	5 4 3 2 1		☐ Stable head when eyes moves ☐ Eye movement independent from head movement ☐ Smooth bilateral coordination of eyes ☐ Associated reactions with mouth	☐ Stable visual field when head is moved passively
Head horizontal	5 4 3 2 1			

Standing balance				
Eyes open R leg _______ sec L leg _______ sec	5 4 3 2 1 5 4 3 2 1		☐ Difference in response when eyes are open and closed ☐ Left-right differences ☐ Body swaying ☐ Asymmetry ☐ Touching other leg ☐ Vision to look at feet ☐ Eyes or head not steady ☐ Shifts supporting foot ☐ Exaggerated movements of arms and trunk ☐ Toe ankle movement without displacing feet	<u>Eyes open:</u> ☐ Less than 10 seconds ☐ 10-12 seconds ☐ More than 12 seconds <u>Eyes closed:</u> ☐ Less than 5 seconds ☐ More than 5 seconds
Eyes closed R leg ______sec L leg ______sec	5 4 3 2 1 5 4 3 2 1			

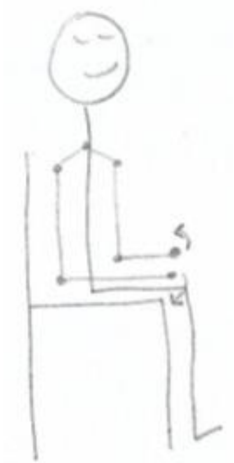
Revised Clinical Observation document (SAISI 2016), SAISI (Cook et al 2016), Dunn (1981:15-16) & OTASA screening tool 2009.

APPENDIX I

Procedure for administration

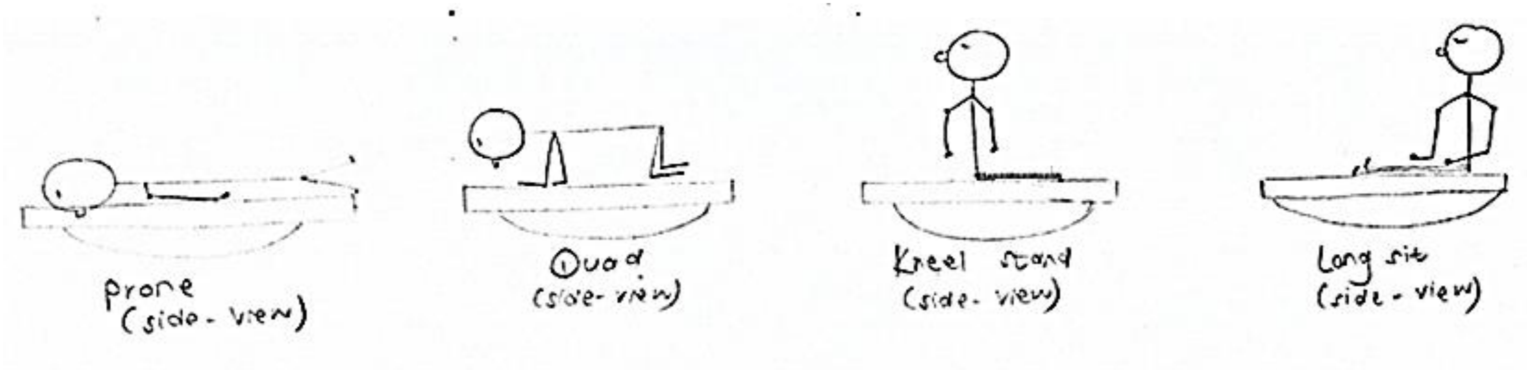
Procedure for administration and scoring of the ten COs subtests.

Procedure for administration of ten subtests was compiled using the revised clinical observation document (Cook, Olivier, Van Jaarsveld, 2016), SAISI (2005) administration and scoring booklet and Dunn's (1981) guide to testing clinical observations in kindergartens. All pictures were drawn by the researcher, but credit is given to Dunn (1981) for informing the structure of many drawings (PEP, ATNR, STNR, SFP and FTN test).

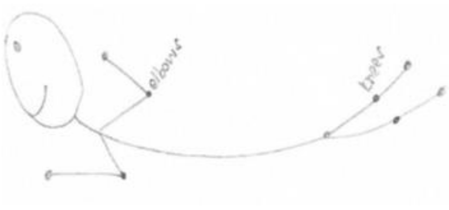
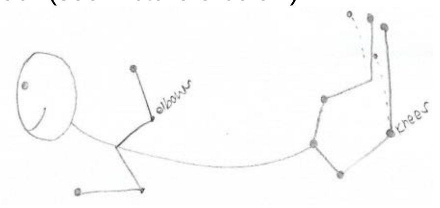
Equipment	Positioning	Procedure	Scoring and termination of procedure	Allocation of grade score
1. DIADOKOKINESIS				
Stopwatch and chair.	Seated across child, elbows flexed and forearms resting on lap (see Picture 1 below).  *Picture 1: DDK*	Examiner demonstrates rotation of forearm on ipsilateral side of child's dominant/preferred hand. Child is asked to watch the examiner while she demonstrates. When child grasps concept examiner says: *I want to see how many times you can do that with this arm* (examiner points to right arm). *I'll tell you to stop, ready GO.* Repeat instructions for left hand and both hands.	Count the number of times the child's hand slaps on the thigh(s) after an arm rotation and within 10 seconds. The recording is stopped once the 10 seconds has lapped or if the child double taps or breaks down the performance before 10 seconds. If this occurs, record the number of patterns up until the breakdown occurred.	Grade 1: Unable to perform. Grade 2: Definitely deficient (less than 4 patterns). Grade 3: Moderately deficient (4 patters and 4+ SNH parameters present). Grade 4: Adequate, slight inconsistencies (more than 4 patterns and 2-4 SNH parameters present). Grade 5: Normal (more than 4 patterns and only 1 or 0 SNH parameter present).

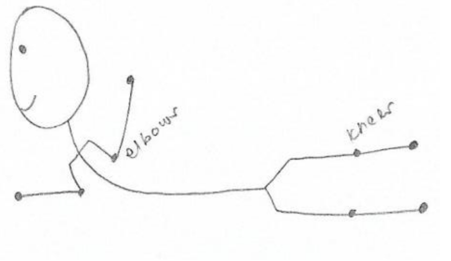
Equipment	Positioning	Procedure	Scoring and termination of procedure	Allocation of grade score
2. THUMB-FINGER TOUCHING				
Chair.	Child is seated across examiner with forearms supported on lap.	Examiner's thumb touches each finger sequentially (index to little finger, touch little finger again and back in sequence to index finger), no auditory cues are given. Examiner says: *Now you do it. Do it with this hand* (point to preferred hand). Repeat instructions with non-preferred hand *now you do it, do it with this hand*, both hands *now you do it, do it with both hand* and with eyes closed, *now you do it with both hands and eyes closed.* (See Picture 2 below).  *Picture 2: TFT*	Stop after child performed the action.	Grade 1: Unable to perform. Grade 2: Poor performance with inconsistencies in the pattern. Grade 3: Irregular but able to perform basic pattern. Grade 4: Coordinated and correct pattern. Grade 5: Well-coordinated, fluid and correct pattern.

<u>**Equipment**</u>	<u>**Positioning**</u>	<u>**Procedure**</u>	<u>**Scoring and termination of procedure**</u>	<u>**Allocation of grade score**</u>
3. EQUILIBRIUM REACTIONS				
Covered tilt board and carpet or therapy mat.	Examiner supports board while child climbs on and lie prone facing examiner. Child needs to be centered on board and will after prone, continue with quadruped, upright kneel and then long sit positions. In *prone* the child lies with his/her arms supinated to the sides and head turned to the side. In *four-point kneel* and *kneel-stand* flexion of 90° is maintained at hip and/or knees, as is relevant. In *long sit position*, the child sits on the board, legs extended, hands are pronated and placed on the thighs. See Picture 3 below for positioning.	Examiner says: *This is your boat, I am going to move the boat and you must try not to fall off, are you ready.*	Tilt the board 3-4 times to each side during the different positions, or until examiner feels comfortable with the observed performance. The child is then asked to take in the next position on the tilt board. Stop after all four positions have been administered.	Grade 1: Definitely deficient, unable to perform. Grade 2: Poor integration of equilibrium reactions. Grade 3: Slightly deficient (4 SNH parameters present). Grade 4: Normal some execution difficulties (3 SNH parameters present). Grade 5: Normal reaction (1-2 SNH parameters present).

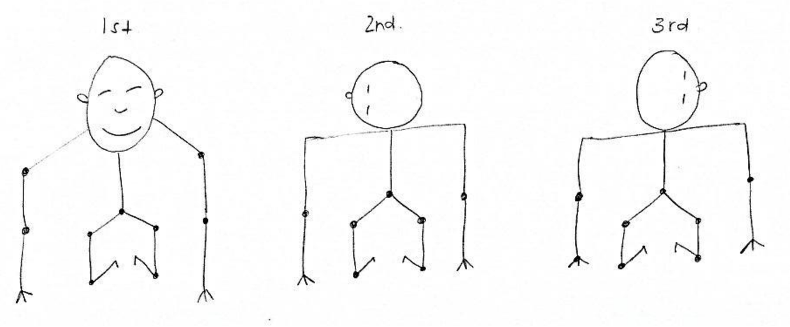


Picture 3: Positioning of ER

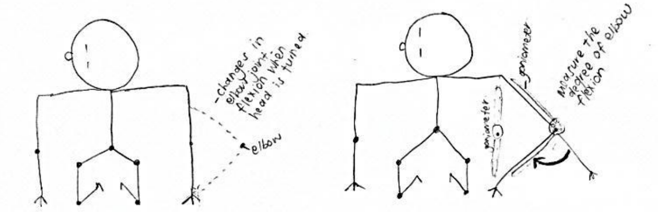
Equipment	Positioning	Procedure	Scoring and termination of procedure	Allocation of grade score
4. PRONE EXTENSION POSTURE				
Stopwatch and carpet or therapy mat.	Initial position: the child is lying in prone on the carpet. The *full PEP* entails the child to fully extend neck and trunk , with shoulders abducted and retracted, elbows flexed 90°, hips extended and knees straight (see Picture 4 below).  *Picture 4: Full PEP* *PEP bent legs*: Child is in prone, neck and trunk extended, elbows flexed 90°, hips extended and knees bend 90° (see Picture 5 below).  *Picture 5: PEP bent legs*	Examiner says *We are going to pretend that we are an airplane and I want to see how long you can keep this position that I am going to show you.* Examiner demonstrates full PEP position and says *now you do the same thing and count aloud se we can see how long you can fly and stay that way.* See if the child is able to perform the full PEP, if child is able, stop and asked to rest before starting formal scoring procedure. If child is unable to perform full PEP, but able to maintain posture with bent legs (even after examiner reminds to straighten legs), the child is scored on PEP bent legs. If child is unable to perform full PEP with or without straight legs, the child is shown how to perform the PEP arms only position. Child is given the opportunity to show the examiner he/she understands, and takes in the position. The child is immediately stopped and asked to rest before starting formal scoring procedure.	The child is firstly asked to take in the position to see whether the child understands, whereafter the child is immediately stopped and asked to rest (take in initial position). The child is then reminded of the instructions, and on the count of 3 the child lifts up either legs (knees), arms and head or just arms and head. The examiner then starts recording. The examiner keeps her fingers under the child's knees and if the knees, legs, arms and/or head touches the floor, the recording is stopped.	Grade 1: Holds for 0-4 seconds. Grade 2: Holds for 5-10 seconds. Grade 3: Holds for 11-15 seconds. Grade 4: Holds for 15-20 seconds (at least 1-3 SH parameters present). Grade 5: Holds for 15-20 seconds (more than 3 SH parameters present).

	PEP arms only: Child is in prone, neck and trunk extended, elbows flexed 90° and lower limbs on the floor (see Picture 6 below).  *Picture 6: PEP arms only*			

Equipment	Positioning	Procedure	Scoring and termination of procedure	Allocation of grade score
5.1 ASYMMETRICAL TONIC NECK REFLEX				
Goniometer and carpet or therapy mat.	Child assumes a four-point kneel position on the carpet with hips, knees and shoulders at 90° flexion. Hands flat, fingers facing forward and slightly inwards, ensure that elbows are not locked in hyperextension. Examiner sits in front of child holding his/her head firmly at the cheeks.	Examiner says: *Let me turn your head*, rotate head 90°, chin and shoulders in line. Examiner says *hold it there while I measure*. Examiner measures opposite arm's elbow flexion and turns head back to neutral position. Repeat to other side. (See Pictures below).	The center of the goniometer is placed at the lateral epicondyle of the humerus, with the fixed arm positioned at the midline of the humerus with reference to the acromion process. The moveable arm faces the lateral midline of the styloid process of the ulna. The examiner terminates the procedure once the degree of flexion has been recorded. Only one recording per side is made. (See Picture 8).	Grade 1: Elbow flexion more than 45°. Grade 2: Elbow flexion between 35-45°. Grade 3: Elbow flexion between 25-35°. Grade 4: Elbow flexion less than 25°, with 2 SNH parameters present. Grade 5: Elbow flexion less than 25°, 1 or less SNH parameter present.

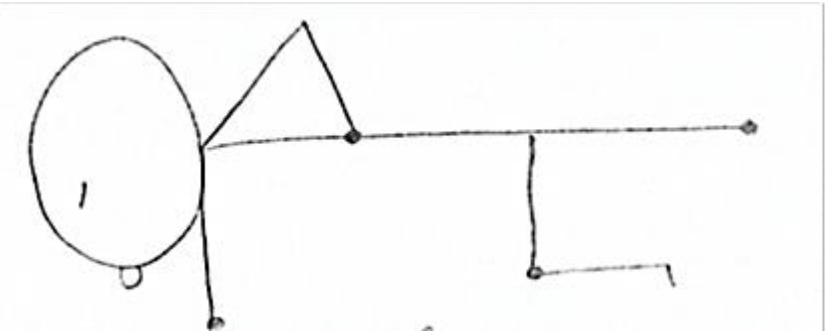


Picture 7: The position the reflexes is tested in.



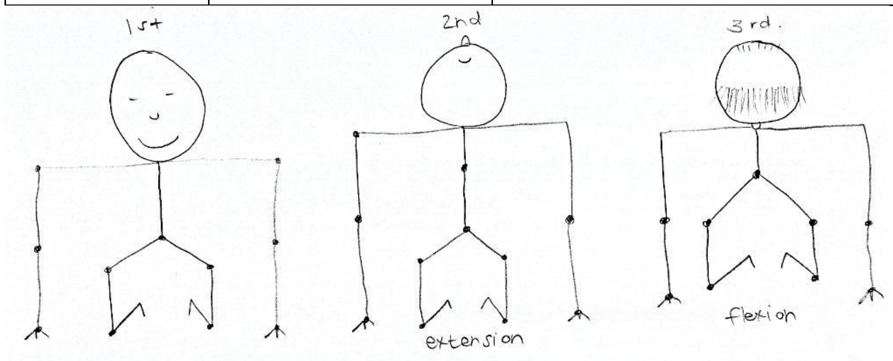
Picture 8: Scoring of reflexes: a goniometer is used (as described under scoring and administration of procedure), to measure the degree of elbow flexion present.

Equipment	Positioning	Procedure	Scoring and termination of procedure	Allocation of grade score
5.2 REFLEX INHIBITING POSTURE (RIP)				
Stopwatch and carpet or therapy mat.	Child is in four-point kneeling position on the carpet. Child places left hand on left hip while lifting opposite (right) leg and turning head to left side. Same done to the right side. (See Picture 9 below).	Examiner points to child's left hand and says *put your left hand here* (examiner touches child's left hip), *now lift this leg and hold it up* (examiner touches child's right leg), *and now turn your head to the side* (examiner indicates left side). Repeat instructions with head turned to the right.	The examiner firstly asks the child to hold in the position to make sure the child understands the instructions, where after the child takes in the resting/initial position and the recording starts once the child takes in the reflex inhibiting posture. The examiner stops the time when the child's upper or lower limbs touch the ground, if the child loses balance and falls over, if the child takes his/her hand of the hip and if the child moves his head. The child is given two attempts and the best attempt is recorded.	Grade 1: Hold position for 0-1 second. Grade 2: Hold position for 2-3 seconds. Grade 3: Hold position for 4-5 seconds. Grade 4: Hold position for 4 seconds with 3 SH parameters present. Grade 5: Hold position for 5 seconds and more, with more than 3 SH parameters present.

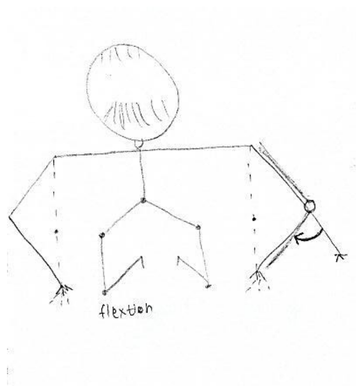


Picture 9: RIP

Equipment	Positioning	Procedure	Scoring and termination of procedure	Allocation of grade score
5.3 SYMMETRICAL TONIC NECK REFLEX				
Goniometer and carpet or therapy mat.	Similar positioning as ATNR. Examiner sits in front of child holding firmly at cheeks.	Examiner says: *Let me move your head*, examiner moves head and neck into extension then into flexion. Examiner says: *hold it there while I measure*. Examiner measures elbow flexion of both arms while neck is flexed. (See Pictures below).	The center of the goniometer is placed at the lateral epicondyle of the humerus, with the fixed arm positioned at the midline of the humerus with reference to the acromion process. The moveable arm faces the lateral midline of the styloid process of the ulna. The examiner terminates the procedure once the degree of flexion has been recorded. Only one recording per side is made.	Grade 1: Elbow flexion more than 45°.
				Grade 2: Elbow flexion between 35-45°.
				Grade 3: Elbow flexion between 25-35°.
				Grade 4: Elbow flexion less than 25°, with 2 SNH parameters present.
				Grade 5: Elbow flexion less than 25°, 1 or less SNH parameter present.

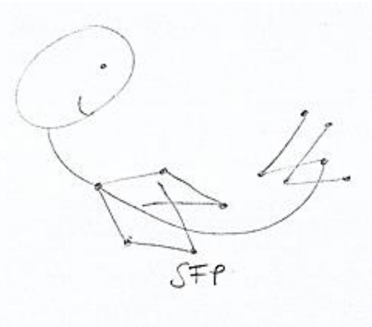


Picture 10: Positioning of STNR.



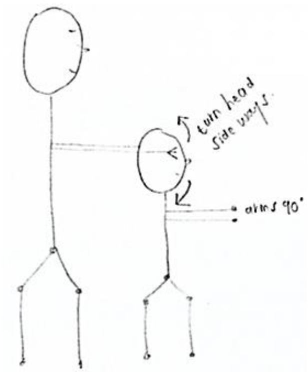
Picture 11: Measuring the degree of elbow flexion

Equipment	Positioning	Procedure	Scoring and termination of procedure	Allocation of grade score
6. SUPINE FLEXION POSTURE				
Stopwatch and carpet or therapy mat.	Child lies supine on the carpet with legs extended and arms crossed on chest.	Examiner says *Watch me* and assumes the position (simultaneously flexing neck and legs). See Picture 12 below. *I want you to do the same thing, count aloud so we can see how long you can stay that way.* After the child held the position the examiner says *Relax, now curl up your legs and your head so you go into a ball, don't let me push you* (examiner gives resistance against forehead and knees).	The child is firstly asked to take in the position to see whether the child understands, where after the child is immediately stopped and asked to rest (take in initial position). The child is then reminded of the instructions, and on the count of 3 the child takes in the position. Start recording once the legs and neck are lifted off the ground. Stop the recording when the child breaks the posture, either by touching the floor with the legs, arms and/or the seventh neck vertebrae (nape of the neck). Resistance of posture is held for 3-5 seconds.	Grade 1: Unable to assume, less than 5 seconds.
				Grade 2: Holds for 5-10 seconds.
				Grade 3: Holds for 10-15 seconds.
				Grade 4: Holds for 15-20 seconds (1-3 SH parameters present).
				Grade 5: Holds for 15-20 seconds (more than 3 SH parameters present).



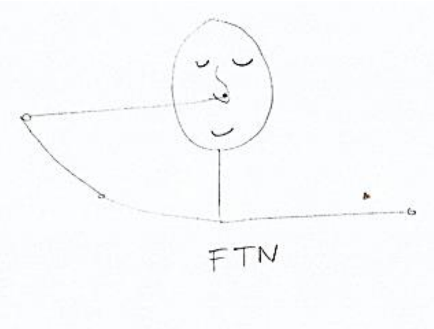
Picture 12: SFP

Equipment	Positioning	Procedure	Scoring and termination of procedure	Allocation of grade score
7. SCHILDER'S ARM EXTENSION TEST				
Carpet or therapy mat.	Child is standing, feet together, arms stretched forward, fingers spread and eyes closed.	Examiner says *Stand with your feet together, arms stretched forward with your fingers spread out and close your eyes. Keep your arms just where they are and count out loud to 20.* Thereafter the child is asked to take in the same position, but the examiner stands behind the child, and grasps the head firmly by placing hands over the child'scheeks. Child's eyes remain closed. Examiner says *let me turn your head. Keep your arms just where they are.* Examiner rotates head slowly to 90° to level shoulder and chin, return to midline and turn head to the other side. (See Picture 13 below).	Stop the first and second recording once the child and/or examiner counts to 20.	Grade 1: Unable to hold position. Grade 2: Definite postural changes in arms and trunk. Grade 3: Slight postural changes in arms and trunk. Grade 4: Holds position with 2-4 SNH parameters present. Grade 5: Holds position with minimal to no postural changes.



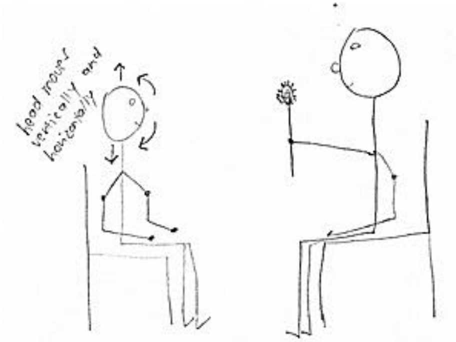
Picture 13: SAE

Equipment	Positioning	Procedure	Scoring and termination of procedure	Allocation of grade score
8. FINGER-TO NOSE				
Chair.	Child sits opposite the examiner facing each other. Child's arms are extended and abducted 90°.	Examiner says: *I want you to bring your finger in to touch your nose, do it one hand at a time, with your eyes closed.* Examiner demonstrates action to the child. (See Picture 14 below.)	The examiner zooms in with the video camera up to the child's shoulders. The child is asked to perform the action and stopped once each side's index finger has touched the nose 2-3 times. Touching the tip of the nose within 1.5 cm was verified on the computer. The examiner had a 1.5 cm red dot that was placed on the computer screen. The initial scoring and verification on the computer was taking into consideration before making a conclusion about the child's ability to touch the tip of the nose.	Grade 1: Unable to perform the action. Grade 2: Definite difficulty performing the action. Grade 3: Slight deficient with 3 and more SNH parameters present. Grade 4: Smooth and accurate, with 2-3 SNH parameters present. Grade 5: Smooth and accurate with 0-1 SNH parameter present.



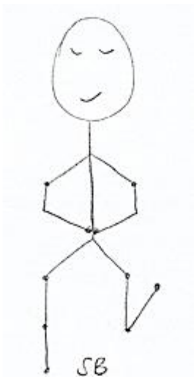
Picture 14: FTN

Equipment	Positioning	Procedure	Scoring and termination of procedure	Allocation of grade score
9. GAZE STABILITY				
Chair and pencil with a rubber pencil puppet on top.	Child sits opposite the examiner facing each other. (See Picture 15 below).	Examiner says *I am going to keep the puppet in front of you, I want you to move your head up and down (nodding yes), but keep your eyes on the puppet.* If child does not fully understand, the examiner will demonstrate. *Now I want you to move your head sideways (nodding no), but keep your eyes on the puppet.* Examiner will demonstrate if necessary.	Stop the action once the child moves his/her head approximately 3-5 times nodding yes and no, or until the examiner is comfortable to administer the subtest with the performance observed.	Grade 1: Unable to perform the action. Grade 2: Definite difficulty performing the action. Grade 3: Slightly irregular (3+ SNH parameters present). Grade 4: Smooth and accurate eye movement with 2-3 SNH parameters present. Grade 5: Smooth and accurate eye movement with 0-1 SNH parameter present.



Picture 15: GS

Equipment	Positioning	Procedure	Scoring and termination of procedure	Allocation of grade score for eyes open	Allocation of grade score for eyes closed
10. STANDING BALANCE					
Stopwatch	Child stands in front of examiner.	Examiner demonstrates the action to the child, by placing both hands on the hips and flexing the left knee at a 45° angle. The child is then asked to *stand on the right leg* (examiner points to the leg). As soon as the child lifts up the leg, the examiner starts recording the time. Same process is followed with the opposite leg. Then examiner says to the child *now you are going to stand on one leg with your eyes closed.* If necessary the examiner can demonstrate the task again. Repeat same procedure for the opposite leg. (See Picture 16 below).	The recording of the time starts immediately after the child lifts up the leg. If any body part, expect the balancing foot touches the floor, stop the time. The time is also stopped once the balancing foot moves out of position, shifting toes or foot. The child gets two attempts per leg. Record the best attempt. Repeat the same process with eyes closed.	Grade 1: Stand on one leg for 1-2 seconds.	Grade 1: Stand on one leg for 0-1 second.
				Grade 2: Stand on one leg for 3-4 seconds.	Grade 2: Stand on one leg for 2-3 seconds.
				Grade 3: Stand on one leg 5-7 seconds.	Grade 3: Stand on one leg for 4 seconds.
				Grade 4: Stand on one leg for 8-10 seconds.	Grade 4: Stand on one leg for 5 seconds.
				Grade 5: Stand on one leg for more than 10 seconds.	Grade 5: Stand on one leg for more than 6 seconds.



Picture 16: SB

APPENDIX J

Feedback letter to parents

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

Dear Parent/Guardian

Thank you for allowing your child to participate in the research study.

I would like to give you feedback with regards to your child's performance on the ten subtests I conducted.

Name of child: ____________________________

Age at assessment: ____________________________

Please refer to the summary of the results at the back of this letter.

☐ I am concerned regarding your child's performance on the ten subtests.

☐ I am not concerned regarding your child's performance on the ten subtests.

Please note this was not a formal assessment and your child's performance on the specific day might not reflect his/her abilities. If you would like a more in depth evaluation, your school will provide you with contact details of occupational therapists in the area.

You are welcome to contact me should you like more information about the specific research study and/or your child's performance on the ten subtests.

Yours sincerely

____

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UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

Name of child			
TEST ITEM	**YOUR CHILD'S PERFORMANCE**		**AGE EXPECTATIONS**
Sequential hand and leg slaps	Yes Sometimes No	______ times	4 times in 10 seconds
Thumb finger touch	Yes Sometimes No		Not expected at age 5 years
Balance on moving object	Yes Sometimes No		Maintains balance
On stomach lift up arms and head, hold position	Yes Sometimes No	______ sec	15-20 seconds
ATNR & STNR Reflexes still present	Yes Sometimes No		Should not be present anymore
Lie in a ball position on carpet	Yes Sometimes No	______ sec	15-20 seconds
Keep standing position when head is turned to the sides	Yes Sometimes No		Keep position
Touch nose with finger with eyes closed	Yes Sometimes No		Touch nose accurately within 1.5 cm
Move head while making eye contact with an object	Yes Sometimes No		Can follow object
Balance on one leg with eyes open and closed	Yes Sometimes No	_______ sec	Balance for 10- 12 seconds
Comments:			

APPENDIX K

Example of data scoring sheet

Example of first sheet – general information and DDK right hand.

Nr	Date _y	Date _m	Date_ d	Gender	SES	Dom. hand		Grade_ R	Times _R	DDK_ R_1	DDK_R_ 2	DDK_ R_3	DDK_R _4	DDK_ R_5	DDK_R _6	DDK_R _7	DDK_R _8
1	2011	4	10	2	2	1		4	13	1	1	1	1		1		
2	2011	5	6	2	2	1		5	14	1	1	1	1				
3	2011	7	22	1	2	1		4	14	1		1					1
4	2011	1	30	1	2	2		5	8	1	1	1	1				
5	2011	3	26	2	2	1		4	12	2	1	1	1				
6	2011	6	21	2	2	1		5	12	2	1	1	1				
7	2011	6	23	2	2	1		2	2	1		1		1			1
8	2011	7	12	1	2	1		5	11	2	1	1	1				
9	2011	6	8	1	2	1		4	16	1		1	1				1
10	2011	7	6	1	2	1		5	14	2	1	1	1				
11	2011	7	22	1	2	1		4	13	2		1	1				1
12	2011	2	8	1	1	1		4	11	2	1	1	1				1
13	2011	2	23	1	1	1		5	13	2		1	1				1
14	2011	3	16	1	1	1		4	13	1		1	1				1
15	2011	4	8	2	1	1		2	3	2	1	1		1			
16	2011	5	1	2	1	1		4	12	2	1	1	1				
17	2011	5	27	1	1	1		5	13	2	1	1	1				
18	2011	6	9	2	1	1		5	12	2	1	1	1				
19	2011	2	8	2	1	1		4	14	1		1	1				1
20	2011	5	20	1	1	1		3	15	2		1		1			1

Example of second sheet – TFT right hand.

Nr	Grade_R	TFT_R_1	TFT_R_2	TFT_R_3	TFT_R_4	TFT_R_5	TFT_R_6	TFT_R_7	TFT_R_8
1	5	1	1	1	1	1	1		
2	2	1	1		1				
3	4	1	1	1					
4	2		1					1	
5	4	1	1		1	1	1		
6	5	1	1	1	1	1	1		
7	3	1	1		1				
8	3	1	1	1					
9	3	1	1						
10	3	1	1						
11	4	1	1			1	1		
12	5	1	1	1	1	1	1		
13	4	1			1	1	1		1
14	5	1	1	1	1	1	1		
15	3	1	1		1		1	1	
16	4	1	1		1	1	1		
17	4	1	1		1	1			
18	2	1	1					1	
19	3	1	1		1		1		
20	3	1	1		1				

APPENDIX L

Concept clarification of COs items' SH and SNH Parameters

Concept clarification of SH and SNH parameters used in the measuring instrument (cf. Appendix G).

The concept clarification is discussed in the same sequence as it appears on the measuring instrument.

1. DIADOKOKINESIS (DDK)			
SH PARAMETERS	**CONCEPT CLARIFICATION**	**SNH PARAMETERS**	**CONCEPT CLARIFICATION**
Start position	*First forearm rotation (either supination or pronation).*	Inco-ordination	*Definite disruption of movement pattern. Hesitation present.*
Isolated forearm movements	*Movements of the forearm only. No movement above the elbow.*	Associated reactions with mouth	*Movement of the tongue and/or lips.*
Position of thumb next to index finger	*Thumb is positioned next to the index finger through the duration of the DDK test.*	Associated reactions with other hand	*Any movement of the contralateral hand and or fingers, while performing the action.*
Rhythmical movement	*Action is performed rhythmically with no disruptions in the rhythm.*	Fixation of upper arm	*Contracting and fixating muscles of the arm.*
		Rigid body	*Rigid body, fixating and contracting muscle of the body.*
		Shoulder elevation	*Lifting shoulders upwards.*
		Use vision	*Any contact the eyes make with the hands/arms.*
		Slaps hard on legs	*Definite increase in force with which the palm(s) slaps the thighs.*
		Unusual movement of fingers	*Any movement of the finger(s).*
		Sloppy movement	*Movement is sloppy almost indicating a low tone in the upper arms.*
		Extreme caution in movement	*Very careful performing the action. Placing hands "softly" on the thighs.*
		Double tap	*Slapping same side of palm twice on the thigh.*
		Press elbow against body	*Press elbows in the sides of the body.*
		Absence of supination	*Dorsal side of hand hits leg partially.*
		Hands not flat	*Hands are c-curved.*
		Rolling forearm on leg	*Forearm remains on leg, no lifting of arms, only rolling.*

2. THUMB-FINGER TOUCHING (TFT)			
SH PARAMETERS	**CONCEPT CLARIFICATION**	**SNH PARAMETERS**	**CONCEPT CLARIFICATION**
Thumb opposition	*Ability to turn and rotate the thumb to touch fingers.*	Starting position	*Taps on any other finger but index.*
Touch fingers with tip of thumb	*Touch fingers with tip of thumb.*	Restart pattern	*Started pattern, stopped and started again.*
Double tap on 5th finger	*Able to double tap little finger.*	Lose sequence when returning from 5th finger	*Touching fingers in sequence from thumb to 5th (little finger) in correct sequence, but lose sequence on return from 5th finger.*
Isolated finger movements	*Moving one finger at a time while other fingers stay in position.*	Slow movement	*Performs the action very slowly.*
Correct sequence touching fingers 2-5 and back	*Touching fingers in correct sequence starting and ending at thumb.*	Sloppy movement	*Performs the action sloppy, appearance of low tone in the fingers.*
Good timing	*Touch fingers without resting periods or long intervals in between.*	Associated reactions with mouth	*Movement of tongue and or lips (biting lip, moving tongue in and/or outside of mouth).*
		Associated reactions with opposite hand	*Any movement of the contralateral hand, while performing the action.*
		Reliance on visual input	*The eyes make contact with the hand while performing the movement.*
		Tactile input (slide finger)	*Slide thumb along fingers.*
		Proprioceptive input (press hard)	*Press hard on fingers.*
		First perform action with one hand then the other	*First performs action with ipsilateral hand then continue onto contralateral hand, does not perform action with both hands simultaneously.*
		Restart same forward sequence	*Touches thumb to 5th finger and restart again touching thumb to 5th finger (no reverse sequence).*
		Double tap each finger (2-5th finger)	*Double tap 2nd finger, double tap 3rd finger, double tap 4th finger and double tap 5th finger (in this order).*
		Correct pattern but performs in reverse (5th-1st finger)	*Starts with 5th finger and ends with thumb (reverse pattern).*

3. EQUILIBRIUM REACTIONS (ER)			
SH PARAMETERS	**CONCEPT CLARIFICATION**	**SNH PARAMETERS**	**CONCEPT CLARIFICATION**
Trunk rotation	*Rotates trunk.*	Relies on protective extension	*Responds using movement of arms and/or legs, lifting arms and legs in the air.*
Elongation of weight bearing side	*"Straightening / stretching" weight bearing side of the body.*	Rigid response	*Contracting and fixating muscles, resulting in a rigid body.*
Flexion of non-weight bearing side	*Flexing non-weight bearing side (bring shoulder towards hip).*	Widen base of support	*Making base of support larger, by placing extremities further away from one another.*
Weight shift	*Shifting weight.*	Lower centre of mass	*Lower centre of mass by lowering upper body. In four point kneel child flexes elbows or lowers buttocks, and in long sit child lowers upper body, actively bringing shoulders forward or bends the knees more to lower buttocks while researcher moves the board.*
Fluid response	*Fluidly and smoothly changes position, no jerky movement.*	Holds onto equilibrium board	*Uses hands to hold onto board.*
		Lordosis and and anterior tilt of pelvis	*Pushing out buttocks, creating curve in the lumbar spine.*
		Arm abduction less than 45°	*Slightly abducting/lifting arm less than 45°.*
		Arm abduction more than 45°	*Abducting/lifting arm higher than 45°.*
		Fixate arms against body	*Contracting muscles of the upper limbs and pressing them against body.*
		Associated reaction with mouth	*Movement of tongue and or lips (biting lip, moving tongue in and/or outside of mouth).*
		C-curve in upper trunk (shoulder and back)	*C-curve present in shoulders and back (thoracic spine).*
		Grasps onto clothes	*Grabs on to own clothes to gain more stability.*
		Press or lock feet together	*Press feet together, place one foot over the other.*

4. PRONE EXTENSION POSTURE (PEP)			
SH PARAMETERS	**CONCEPT CLARIFICATION**	**SNH PARAMETERS**	**CONCEPT CLARIFICATION**
Lifts limbs simultaneously	*Simultaneously lifts both arms and legs.*	Assumes posture segmented	*Assumes posture by first lifting lower or upper limbs.*
Head vertical ≥ 45°	*Head lifted off floor, and neck extending 45°.*	Head raised less than 45°	*Head slightly raised of the floor. Neck extended less than 45°.*
Head held steady	*No movement of the head, head stays in same position throughout the posture.*	Back appears flat or minimally arched	*Straight back with no definite arch.*
Arch in upper trunk	*Arch in back.*	Elbows forward of shoulders	*Elbows in front of shoulders.*
Elbows with or behind shoulders	*Elbows in line of shoulders or at back of shoulders.*	Thighs barely off mat	*Paper can be slid under knee, not much above.*
Thighs off mat, from mid-thigh distally	*Mid-thighs not touching carpet.*	Definite flexed knees (more than 50°)	*Knees bent between 50°-90°. (Just below 90°, not to be seen as PEP bent legs position).*
Knees bent (45° or less)	*Knees slightly bend.*	Excessive effort required to maintain posture	*Child is struggling to maintain posture – can see in facial and body expressions.*
		Unable to count out loud	*Child is unable to count aloud while maintaining posture.*
		Fixation of body	*Contracting muscles of the body, giving a "stiff" appearance.*
		Rocking body	*Moving side-ways or forward-backward (rocking like a boat).*
		Asymmetry between sides	*Difference between positioning of left and right side. One side higher than the other.*
		Elevation of shoulder	*Lift shoulders upwards (towards ears).*
		Unable to lift knees off the ground	*Unable to lift knees.*
		Stabilise legs placing one foot over another	*Place one foot over another.*
		Associated reactions with mouth	*Movement of tongue and or lips (biting lip, moving tongue in and/or outside of mouth).*

5. ASYMMETRICAL TONIC NECK (ATNR)			
SH PARAMETERS	**CONCEPT CLARIFICATION**	**SNH PARAMETERS**	**CONCEPT CLARIFICATION**
No changes in joint position	*No elbow flexion present. Elbow joint stays the same.*	Elbow flexion of contralateral arm	*Elbow flexion of contralateral arm present, more than 25°.*
Elbow flexion present but less than 25°	*Elbow flexion present within 25°.*	Resistance to head turn	*The child gives resistance with his head when turned.*
		Tends to lock elbows	*Lock elbows.*

REFLEX INHIBITING POSTURE (RIP)			
Head held steady	*Head position is unchanged from start to end of posture.*	Tends to lock elbows	*Lock elbows.*
Able to assume posture fluently	*Able to keep posture without experiencing difficulty.*	Open shoulder and turn body	*Open shoulder (shoulder facing the ceiling) and gives the impression that he/she is turning the body.*
Able to keep chin against shoulder	*Child can independently keep chin against shoulder for the duration of the action.*	C-curve in back and shoulders	*Back and shoulders are c-curved.*
Straight back	*Back appears straight.*	Excessive lordosis of back	*Inward curve of the lumbar spine.*
Leg and knee in line with hip (90°)	*Leg is lifted high enough to form a straight line between leg and hips.*	Retracts chin in body	*Pushes chin into chest.*
Straight leg (0-45°)	*Leg straight. Bent knee between 0-45°.*	Body sway	*Body is moving to the sides (rocking).*
Head in line with back	*Head and back in line, head not above or below back.*	Associated reactions with mouth	*Movement of tongue and or lips (biting lip, moving tongue in and/or outside of mouth).*
Elbow flexion present not more than 25°	*Elbow flexion present within 25°.*	Elbow flexion of contralateral arm	*Elbow flexion of contralateral arm present, more than 25°.*
		Resistance to head turn	*Child gives resistance with his head, when turned.*
		Tends to lock elbows	*Lock elbows.*

SYMMETRICAL TONIC NECK REFLEX (STNR)			
SH PARAMETERS	**CONCEPT CLARIFICATION**	**SNH PARAMETERS**	**CONCEPT CLARIFICATION**
No changes in joint position	*No elbow flexion present and palms flat on the floor.*	Elbow flexion more than 25°	*Elbow flexion of contralateral arm present, more than 25°*
		Posterior pelvic tilt	*Pelvic tilt backwards.*
		Rounded / arched back	*Back appears rounded.*
		Excessive extension of elbows	*Elbows extended or straighten.*
		Anterior pelvic tilt	*Pelvic tilt forward.*
		Lordosis of back	*Inward curve of the spine.*
		Tends to lock elbows	*Lock elbows.*
		Resistant to head turning	*Child gives resistance with his head, when turned.*

6. SUPINE FLEXION POSTURE (SFP)			
SH PARAMETERS	**CONCEPT CLARIFICATION**	**SNH PARAMETERS**	**CONCEPT CLARIFICATION**
Lifts limbs simultaneously	*Simultaneously lifts both arms and legs.*	Assumes posture segmented	*Assumes posture by first lifting lower or upper limbs.*
Neck flexion ≥ 45°	*Head lifted off floor, and neck flexing 45° and more.*	Chin lead	*Leading head with chin to take in flexed position (pushing out chin).*
Head held steady	*No movement of the head, head stays in initial position throughout the action.*	Retracts chin in body	*Pushes chin in chest.*
C-curve in upper trunk	*C-curve in shoulders and back.*	Neck flexion less than 45°	*Head slightly raised of the floor. Neck flexed less than 45°.*
Can keep legs and neck against resistance	*Can keep posture when examiner pushes down on neck and knees.*	Trunk and shoulders in line	*No definite curve present.*
		Effort required	*Takes effort for child to maintain posture. Can see in facial and body expressions.*
		Head lag before 10 seconds	*Head moves backwards to the floor.*
		Unable to count aloud	*Unable to count aloud while holding position.*
		Fixation of upper limbs	*Contracting and fixating muscles of the upper limbs, giving a "stiff" appearance.*
		Fixation of lower limbs	*Contracting and fixating muscles of the lower limbs, giving a "stiff" appearance.*
		Fisting of hands	*Makes fists with hands.*
		Grabbing onto clothes	*Grabs onto clothes.*
		Press feet together	*Pushes feet together.*
		Placing one foot over the other	*Place on foot over the other.*
		Shoulder elevation	*Lift shoulders upwards (towards ears).*
		Associated reactions with mouth	*Movement of tongue and or lips (biting lip, moving tongue in and/or outside of mouth).*

7. SCHILDER'S ARM EXTENSION (SAE)			
SH PARAMETERS	**CONCEPT CLARIFICATION**	**SNH PARAMETERS**	**CONCEPT CLARIFICATION**
No changes in upper limbs	*Upper limbs stay in original position (arms stretch out in front of child).*	Starting position of arms more than 90°	*Positioning of arms higher than 90°.*
Dissociate head from trunk	*Can move head to the sides without trunk moving to the sides.*	Starting position of arms less than 90°	*Positioning of arms lower than 90°.*
Maintains balance when eyes are closed	*Able to maintain balance when vision is occluded.*	Arms drop less than 45°	*Arms drop less than 45° from the neutral starting position.*
		Arms drop more than 45°	*Arms drop more than 45° from the neutral starting position.*
		Arms raised less than 45°	*Arms raised less than 45° from the neutral starting position.*
		Arms raised more than 45°	*Arms raised more than 45° from the neutral starting position.*
		Spoon hands	*Pushes palms downwards while pushing wrist and fingers upwards.*
		Touching hands to stabilise arms	*Hands touch while stretched in front of body.*
		Able to correct positioning of upper arms	*Upper arms moved and child is able to correct arms into initial starting position (in front of body).*
		Involuntary movements of fingers	*Any movement of the fingers (up, down).*
		Dislike having eyes closed	*Dislike having eyes closed, child has an emotional reaction.*
		Fixation of arms	*Contracting and fixating muscles of the arms, giving a "stiff" appearance.*
		Elevation of shoulders	*Lifts shoulders upward, towards ears.*
		No opening between fingers (1-4)	*Fingers are closed, no space visible between fingers.*
		Asymmetry	*One hand lower than other, mark which is lower.*
		Arms separate	*Arms move away from one another.*
		Resistant to head turning	*Child gives resistance with head, while turning the head.*

(SAE – continued)

	SNH PARAMETERS	CONCEPT CLARIFICATION
	Flexion of elbows	*Bent elbows.*
	Thumb to palm not next to index finger	*Thumb positioned towards palm and not positioned next to index finger.*
	Trunk rotation >45°	*Rotates / turns trunk, more than 45° while head is turned to the sides.*
	Trunk rotation <45°	*Rotates / turns trunk, less than 45° while head is turned to the sides.*
	Horizontal deviation of the arms > 45°.	*While turning head to the side, arms move with head to the side, exceeding 45°.*
	Retracts chin in body	*Pushes chin in chest.*
	Associated reactions with mouth	*Movement of tongue and or lips (biting lip, moving tongue in and/or outside of mouth).*
	Hand drop	*Wrist drop, fingers face the floor.*

8. FINGER-TO-NOSE (FTN)			
SH PARAMETERS	**CONCEPT CLARIFICATION**	**SNH PARAMETERS**	**CONCEPT CLARIFICATION**
Fluid and smooth movement	*Movement of arms smooth and coordinated.*	Turn head to the sides while touching nose	*Child turns head to the right side touching nose with right hand. Same with opposite side.*
Touch tip of nose within 1.5 cm	*Child touch nose with tip of finger, within distance of 1.5 cm of tip of nose.*	Non touching arm flexed 45° or more	*Arm not touching the nose is flexed/bend.*
Arms abducted 90°	*Arms stretch to the side (straight arms), shoulder height.*	Poor rhythm	*Child has poor rhythm, with too much breaks in between arm movement or movement is too fast.*
Miss tip of nose, able to correct	*Child does not touch tip of nose, but corrects positioning of finger by moving finger to tip of nose.*	Loses rhythm	*Child initially has good rhythm but loses it throughout the performance.*
		Touch nose not with tip of finger	*Child touch nose with DIP or PIP joint, not with tip of finger.*
		Retracts chin	*Pushes chin in chest.*
		Associated reactions with mouth	*Movement of tongue and or lips (biting lip, moving tongue in and/or outside of mouth).*
		Press hard on nose	*Finger presses hard on nose. Changes in nose structure visible.*
		Replace finger with opposite hand.	*Child replaces finger with the opposite hand's finger, not coordinated bilaterally.*
		Fixate upper limbs	*Contracting and fixating muscles of the upper limbs, giving a "stiff" appearance.*

9. GAZE STABILITY (GS)			
SH PARAMETERS	**CONCEPT CLARIFICATION**	**SNH PARAMETERS**	**CONCEPT CLARIFICATION**
Stable gaze when head moves	*Eyes can focus on object while moving head.*	Associated reactions with the mouth	*Movement of tongue and or lips (biting lip, moving tongue in and/or outside of mouth).*
Eye movement independent from head movement	*Eyes and head can move independently from one another.*	Lose eye contact when object is in peripheral vision	*When head is turned to the side the child loses contact with the object.*
Smooth bilateral coordination of eyes	*Both eyes move in a coordinated manner.*	Uncoordinated action	*Action done very fast and careless.*
Smooth movement of head	*Head moves smoothly, with good rhythm.*	Slow movement	*Action performed very slowly.*
		Over-exaggerated movement of head	*Over exaggerated extension and flexion of neck.*
		Fixation of upper limbs	*Contracting and fixating upper limbs, giving a "stiff" appearance.*
		Don't move head through full range of motion (ROM)	*Head not moved through full range of motion. Partial movement of head up and down.*

10. STANDING BALANCE (SB)			
SH PARAMETERS	**CONCEPT CLARIFICATION**	**SNH PARAMETERS**	**CONCEPT CLARIFICATION**
Maintain arms in sides	*Hands stay on hips.*	Body sway	*Rocking of body. Moving body to the sides, forward and/or backwards without shifting the balancing foot.*
		Asymmetry	*Definite difference between the child's ability to stand on the right and left leg.*
		Bracing against leg	*Child's leg and/or foot is toucing and resting on the balancing leg.*
		Use vision to look at feet	*Child looks at feet during the duration of the action.*
		Eyes or head not steady	*Child's eyes are wondering and/or child's head is moving.*
		Shift supporting foot	*Child is moving the balancing foot, shifting either the toes and/or heel.*
		Exaggerated movements of arms and trunk.	*Child makes exaggerated movement with trunk and/or arms.*
		Toe and ankle movement without displacing the feet	*Movement of the balancing leg's ankle is present, but no shifting of toes or heel is present. Child's foot stays in original starting position.*
		Anterior tilt of pelvis	*Child pushes out his buttocks, creating a curve in the spine.*
		Grabs onto clothing	*Child grabs onto clothes.*
		Associated reactions with mouth	*Movement of tongue and or lips (biting lip, moving tongue in and/or outside of mouth).*
		Shoulder elevation	*Child lifts up shoulders (toward ears).*
		Fixating body	*Contracting and fixating muscles of the body, creating a "stiff" appearance.*