THE DEVELOPMENT OF A SCREENING INSTRUMENT TO IDENTIFY SENSORY INTEGRATION DIFFICULTIES IN CHILDREN FROM LOW SOCIO-ECONOMIC ENVIRONMENTS

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SASISI

DECLARATION

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ABSTRACT

Developmental difficulties, such as sensory integration difficulties, in children from low socio-economic environments are often only identified and referred for occupational therapy services once they start formal schooling at the age of six or seven years. Occupational therapy services within the public healthcare system are experiencing constraints due to the availability of appropriate, cost effective assessments and limited knowledge of occupational therapists in sensory integration; resulting in inadequate identification of sensory integration problems and inappropriate intervention. Proper and early identification of sensory integration difficulties in children from low socio-economic environments will support appropriate referral and\or provision of relevant sensory integration stimulation programmes to address the identified needs. This study set out to determine if a contextually appropriate screening instrument would provide a tool that can guide community occupational therapists in the identification of children from low socio-economic environments who are at risk of experiencing sensory integration difficulties.

A single study multiphase design with some aspects of the exploratory and explanatory sequential designs within separate phases of the study was used and the study was divided into three phases to ensure a systematic process was followed. Phase 1 followed an exploratory sequential research design and aimed to develop the items for the screening instrument identifying sensory integration difficulties in children of 5 years 0 months to 6 years 11 months from low socio-economic environments. Phase 2 followed an explanatory sequential research design and aimed to field test, refine and determine the internal construct validity and clinical utility of the newly developed sensory integration screening instrument in low socio-economic environments. Phase 3 used a quantitative research design and aimed to establish additional psychometric properties, such as content validity, concurrent validity with the SIPT and sensitivity and specificity testing of the newly developed sensory integration screening instrument.

Phase one focused on the development of activities to be used for observations of sensory integration. Six activities reached a consensus of 70% and was included in the screening instrument, .namely dressing and undressing (80%), walking heel-toe (80%), star jumps (80%), construction with blocks (72%), making clay shapes (75%) and cutting with scissors (72%). Following the identification of these activities, an administration format and scoring system were constructed using activity analysis. This instrument development process resulted in the South African Sensory Integration Screening Instrument (SASISI). An administration manual and training program were developed to ensure standardised assessment of the SASISI.

Phase two of the instrument development phase included the validation of the SASISI. A short pilot test identified several difficulties in the administration and scoring the SAISI. Identified issues were addressed before the SASISI was field tested on a sample of 200 children. Analysis of the demographic area where the sample for construct validity lived indicated severe poverty in all three areas. Age and gender for the sample was evenly spread between boys and girls, as well as the age groups. Children spoke various languages, with Zulu being the most prevalent in Soweto (53%) and Tswana in Alexandra (43%) and Potchefstroom (63%). The internal construct validity of the SASISI was determined using the Rasch model. Although none of the domains adhered to all the criteria for the Rasch model, the results are promising in terms of the SASISI measuring the underlying constructs of sensory integration. An investigation into the clinical utility of the SASISI indicated that the instrument is appropriate for measuring sensory integration in children from low socio-economic environments.

Phase three aimed to establish additional psychometric properties of the newly developed SASISI. All activities showed content validity above the recommended 0.83, with a mean I-CVI of 0.98, a scale level content validity index of 0.98 and a scale-level content validity index of 0.91. Concurrent validity results indicated good content validity of the SASISI vs the SIPT and moderate significant correlations were found between the tests from the SIPT and domains of the SASISI. The sensitivity and specificity of the SASISI were high and ranged between 59.0 and 100 for sensitivity and 66.1 and 100 for specificity. Cut-off points were established for each domain of the SASISI at the points where the sensitivity and specificity were balanced.

In conclusion, six activities were identified that, through the observation of a child's actions, measures the ability to process, integrate and respond purposefully on sensory input. The results indicated that the SASISI showed provisional validity for screening of sensory integration difficulties despite the small sample size. Although further development needs to be done the SASISI is the first instrument developed to assist in identifying possible sensory integration difficulties in an underserved and vulnerable population in SA.

PRESENTATIONS ARISING FROM THIS STUDY

2018. Van der Linde, J. "Phase three in the development of a sensory integration screening instrument for children at risk of having sensory integration difficulties., paper presented at the World Federation of Occupational Therapy, Cape Town, South Africa, 24th May 2018.

2018. Van der Linde, J. "Sensory Integration in low socio-economic environments." paper presented at the International Sensory integration congress, Cape Town, 26th May 2018.

2017. Van der Linde, J. "An investigation into the possible patterns of sensory integration difficulties for children from low socio-economic areas in South Africa.", paper presented at the European Sensory integration congress, Vienna, Austria, 3 June 2017.

2016: Van der Linde*: "Development of a screening instrument to identify sensory integration difficulties in children living in poverty*." paper presentation at the OTASA congress, Johannesburg, South Africa, July 2016.

2015. Van der Linde, J. "Phase two in the development of a screening instrument to identify sensory integration difficulties in children from low socio economic environments in South Africa", presented at the European Sensory integration congress in Birmingham UK, September 2015.

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PUBLICATIONS ARISING FROM THIS STUDY

Van der Linde, J., Casteleijn, D., and Van Jaarsveld, A. 2018. Considerations for developing an occupational therapy instrument for use in low socio-economic environments: A content analysis. Submitted South African Journal of Occupational Therapy for peer review. August 2018.

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NOMENCLATURE/LIST OF ABBREVIATIONS AND SYMBOLS

ADL	Activities of daily living
ADHD	Attention Deficit Hyperactivity Disorder
ASI™	Ayres Sensory Integration
AOTA	American Occupational Therapy Association
ANS	Autonomic Nervous system
BMC	Bilateral Motor Coordination Test
BOT-2	Bruininks-Oseretsky Test of Motor Proficiency Second Edition
CNS	Central Nervous System
CPr	Constructional Praxis Test
DC	Design Copying Test
DCD	Developmental Coordination Disorder
DOH	The National Department of Health
DTI	Diffusion Tensor Imaging
EASI®	Evaluation in Ayres Sensory Integration®
EEG	Electroencephalogram
FG	Figure Ground Test
FI	Finger Identification Test
GRA	Graphesthesia Test
HPA system	Hypothalamus–Pituitary–Adrenal system
ICF-CY	International Classification of Functioning, Disability, and Health: Children and Youth Version
KIN	Kinaesthesia Test
LTS	Localisation of Tactile Stimuli Test
MABC-2	Movement Assessment Battery for Children, Second Edition
MAC	Motor Accuracy Test
MFP	Manual Form Perception Test

MRI	Magnetic Resonance Imaging
OPr	Oral Praxis Test
OTPF-3	The Occupational Therapy Practice Framework 3rd Edition
PEDI	Paediatric Evaluation of Disability Inventory
PPr	Postural Praxis Test
PRN	Postrotary Nystagmus Test
PrVC	Praxis on Verbal Command Test
RCT	Randomised Control Trial
SAISI	South African Institute for Sensory Integration
SASISI	South African Sensory Integration Screening Instrument
SES	Socio-Economic Status
SIPT®	Sensory Integration and Praxis Tests®
SI	Sensory Integration
SP	Sensory Profile
SPD	Sensory Processing Disorder
SPM	Sensory Processing Measure
SPr	Sequencing Praxis Test
SMD	Sensory Modulation Disorder
SV	Space Visualisation Test
SWB	Standing and Walking Balance Test
TSI	DeGangi-Berk Test of Sensory Integration
UNESCO	The United Nations Educational, Scientific and Cultural Organisation
UNICEF	The United Nations Children's Fund
WHO	The World Health Organisation

OPERATIONAL DEFINITIONS

Activity analysis: Activity analysis allows the occupational therapist to analyse the demands of an activity, the skills needed to perform the activity and the cultural meaning of the activity to a person. It considers the tools and resources needed, how the activity is accomplished, how it challenges the client's capacities and the meaning of the activity for the client (AOTA, 2014: S12).

Bilateral integration and sequencing: The ability to use two parts of the body together in a coordinated manner during motor activities. Ayres (1972a) described bilateral integration and sequencing as a dysfunction that includes poor postural abilities, decreased muscle tone and decreased bilateral motor coordination. She considered it to be a type of motor coordination disorder and associated it with vestibular.

Community service occupational therapy: Compulsory community service is required of all newly graduated occupational therapists. This entails one year of practice within the public sector following graduation, to allow for the provision of occupational therapy service in rural and under developed areas. Maseko et. al. (2014: 37) described this as a period of developing and refining skills while contributing to more equitable health services.

Low socio-economic environment: encompasses the physical, social and cultural environments people live in as all these environments includes the physical conditions and area the person lives in, their income or availability of economic resources, level of education, social status and prestige (Abubakar et. al., 2008; Hook et. al., 2013; Miser and Hupp, 2012). A low socio-economic environment describes an environment with a lack of the above resources and that can have a harmful influence on a child's health and well-being.

Object handling includes the ability to reach, grasp and release objects and tools.

Occupations: "The term *occupation,* as it is used in the *Framework,* 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." (AOTA, 2014: S6). These occupations include activities of daily living, instrumental activities of daily living, rest and sleep, education, work, play, leisure and social participation.

Organisation of space and environment: This is the ability to engage and deal with themselves and the environment in a useful way (Smith Roley et. al., 2001a; Ayres, 2005).

Postural ocular control: Kramer and Hinojosa (2010: 209) further states: “postural control is the ability to assume and maintain body positions during static and dynamic movement”. The proprioceptive receptors play a role in stabilising the head for movement during activities according to the task demands and coordinate the movement of the eyes, head and neck (Bundy et. al., 2002).

Praxis: Ayres (1989) described praxis as the process that includes conceptualization or ideation, motor planning and execution.

Psychometrics refers to the systematic and scientific way in which psychological measures are developed and the technical measurement standards (e.g. validity and reliability) required of such measures (Foxcroft and Roodt, 2013).

Screening instrument: Screening instruments are traditionally short, cost effective and provide a comprehensive view of a child’s functioning rather than an in-depth assessment of a specific area (Bédard and Dickerson, 2014).

Sensory integration: Ayres (1972a) proposed that children’s interaction with the environment results in the development of appropriate foundational skills, such as sensory, motor, cognitive and behavioural skills. This interaction is based on the neurological process of taking in sensation from the environment, processing it in the central nervous system and generating appropriate learning and behaviour (Ayres, 1972a; 2005). This neurological process is known as sensory integration (Ayres, 1972a; 2005).

Sensory perception: According to Ayres (2005: 201), sensory discrimination is: “the ability to perceive various aspects of sensation within a system.” Recently the term sensory discrimination was changed to sensory perception (Schaaf and Mailloux, 2015).

Sensory reactivity: Smith Roley et. al. (2001a: 57) describe sensory modulation in behavioural terms as: “the ability to regulate and organise responses to sensation in a graded and adaptive manner, congruent with situational demands.” Recently the term sensory modulation was changed to sensory reactivity (Schaaf and Mailloux, 2015).

Townships: This term refer to the informal settlements in urban residential areas that during the Apartheid era were reserved for non-whites. These areas were usually build on the periphery of towns and cities. Soweto and Alexandra are two of the townships in the Greater Johannesburg area in Gauteng province. Ikageng is the township adjacent to the town of Potchefstroom in the Dr Kenneth Kaunda district of North-West Province. See Figure 6.8: Visual representation of Gauteng and North-West province within South African context.

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Please note that, as some of the appendices were quite long only the first three pages were included in the appendices.

CHAPTER 1: INTRODUCTION

> *"All children are born to grow, to develop, to live, to love, and to articulate their needs and feelings…" — Alice Miller*

1.1 INTRODUCTION TO THE PROBLEM

Normal development in childhood is essential for a child to grow and develop appropriate foundation skills so that they can thrive and reach their potential (Ayres, 2005). Appropriate foundation skills, such as sensory, motor, cognitive and behavioural skills, are developed through interaction with the environments in which they live (Ayres, 2005). Through interaction with the environment, the child receives sensations such as touch, auditory, smell, and vision from outside the body, whereas gustatory, vestibular and proprioception (body position) are experienced from within the body (Smith Roley et. al., 2007). These sensations are processed and integrated within the central nervous system (CNS) and results in the development of motor, social and emotional skills, which are essential performance skills for participation in occupations (Smith Roley et. al., 2001b).

This neurological process of integrating sensation from the environment and using it effectively is known as sensory integration (Ayres, 2005). Optimal brain function is dependent on sensory input. If adequate sensory stimulation is not available at critical periods in development, it will result in difficulties with processing and integrating sensory information, which in turn leads to behavioural and learning difficulties (Mailloux and Parham, 2010). A study by Koenig and Rudney (2010) found a correlation between specific sensory integration difficulties and performance difficulties, such as play, activities of daily living (ADL), as well as school performance. These performance difficulties are due to the child having trouble in processing and integrating sensory information from the environment. The authors found other occupational performance difficulties such as difficulty with the gross motor and fine-motor aspects of ADL, poor feeding, poor language and emotional skills, as well as sleep disturbances (Koenig and Rudney, 2010). Poor school participation and decreased academic achievement, due to poor motor planning, coordination, poor social skills and play skills were further observed (Koenig and Rudney, 2010).

Occupational therapists are involved in promoting health and well-being in children by enabling them to process sensory information and engage in occupations within the environments in which they live.

According to Jacobs and Schneider (2001), the environment is an essential contributor to the information received through the sensory systems during childhood, and the operation of the nervous system reflects the interaction between biological and environmental influences. Some environments, such as living in low socio-economic environments (Ben-Sasson et. al., 2009; Román-Oyola and Reynolds, 2013) or in institutionalised environments (Cermak and Daunhauer, 1997; Cermak, 2009a; 2009b; Jacobs and Schneider, 2001; Lin, 2003), have a negative effect on the development of typical sensory integration and consequently normal development. Living in poverty can have a detrimental impact on the child's cognitive, language, motor and social-emotional skills (Grantham-McGregor, 2007). This is especially true in South Africa, where a high percentage, 62%, of children are living in low socio-economic environments (Statistics South Africa, 2017) and it is suspected that they are at risk of having sensory integration difficulties.

Limited research is however available on the influence of low socio-economic environments on sensory integration in the South African context. A few studies in South Africa have examined the prevalence of sensory integration difficulties in low socio-economic environments. One study, by Van Jaarsveld et. al. (2001a), showed a high prevalence of sensory integration difficulties in children from a low socio-economic background. In four small studies done by students from the University of the Free State, a statistically significant difference was found between children from high and low socio-economic areas with regards to sensory integration difficulties (Van Jaarsveld, 2010). A pilot study that consisted of a retrospective document review, within an outpatient clinic at a public healthcare facility within the North-West province, indicated children were referred for deficient performance in school, being a slow learner, difficulty in paying attention in the class, poor social skills, and poor gross and fine-motor skills. These difficulties appear similar to those reported as sensory integration difficulties (Ayres, 2005).

1.2 BACKGROUND AND SETTING OF THE PROBLEM

The South African Child Gauge 2017 reported that in 2015, 63% of children grew up below the upper poverty line of R 965 per month (Hall and Sambu, 2017). Statistics South Africa (2017) found that 834,000 children in the North-West Province and 1,418,000 children in Gauteng lived below the poverty line. The South African Health Review 2017 indicated that 70.5% of households access healthcare through the public sector, with primary healthcare clinics their first point of entry (Gray and Gray, 2017). Provision is specially made for mothers and children up to the age of six years living in poverty to access free healthcare (National Department of Health, 1994); they access free occupational therapy services for developmental difficulties at public hospitals and primary health facilities.

Provision of occupational therapy services within the public healthcare sector is however plagued by a shortage of staff, with only three occupational therapists per 100 000 population in Gauteng and 1.6 per 100 000 in North-West Province (Gray and Gray, 2017). This shortage of staff results in high workloads, where child development is not seen as a priority and routine assessments are not done unless the child shows signs of severe developmental delay (Slemming and Saloojee, 2013). The opportunity for early intervention is therefore lost.

The National Department of Health (DOH) attempted to alleviate these staffing issues by introducing compulsory community service for occupational therapists in the public sector for a year following their graduation (National Department of Health, 1997). Although the introduction of community service improved staff ratios, the workload is still high and van Stormbroek and Buchanan (2016) found that community service occupational therapists feel frustrated due to limited resources, such as assessments, equipment and even limited clinical knowledge, to assess and treat a specific diagnosis. To improve service delivery to poor communities, the National Department of Health (2017) proposed a re-engineering of the primary healthcare with the plan to develop ideal clinics. The goal of the ideal clinic is to provide preventative, promotive, curative and rehabilitative services by interdisciplinary healthcare teams, closer to where people live (National Department of Health, 2017). As the goals are to provide infrastructure, staffing, equipment, as well as knowledgeable staff, this will be an ideal setting for the early assessment of children and provide services to children within the community (National Department of Health, 2017). From personal experience, children are currently only referred to occupational therapy when there is a clear disability or when they enter Grade R or Grade 1 and the teacher identifies sensory integration difficulties.

Currently, assessment for difficulties in child development, especially sensory integration difficulties are problematic due to staffing issues as well as contextual factors, such as limited funds for assessments and limited knowledge of sensory integration by community service occupational therapists. The gold standard assessment for sensory integration difficulties, the Sensory Integration and Praxis Tests (SIPT) by Ayres (2004), is expensive and due to financial constraints, public healthcare hospitals and clinics cannot afford these tests. The validity of the administration of these tests in this population is questionable, as prescribed instructions in English need to be used (Ayres, 2004). Instructions were translated into one of the 11 official languages, Afrikaans, but there are no translations for the other nine African languages spoken in South Africa (Statistics South Africa, 2017).

Administration of the SIPT further requires post-graduate training and advanced knowledge of sensory integration theory (Van der Linde, 2009). A pilot study by Van der Linde and Olivier (2010), in North-West Province, found that knowledge and understanding of sensory integration difficulties by occupational therapists working in public healthcare are limited.

The results of this study indicated assessments were done by junior or community service occupational therapists, and although the results of the assessments showed these children experienced difficulties with the processing of sensory information, none were identified as such by these occupational therapists (Van der Linde and Olivier, 2010). The delivery of sensory integration services remains a challenge for children growing up in low socio-economic environments.

1.3 PROBLEM STATEMENT

It is evident that current occupational therapists in public healthcare are unable to assess children for sensory integration difficulties. A lack of resources, such as contextual, cost-effective, language appropriate and valid and reliable assessment instruments, impede the detection of sensory integration problems within poor communities. Another area of concern is that community service occupational therapists only have basic knowledge of sensory integration and are unable to identify these difficulties without a specific assessment to guide their decision-making. A possible solution for this problem could be to develop a new cost-effective and contextually appropriate screening instrument for community service therapists to identify if a child is at risk of experiencing sensory integration difficulties.

1.4 RESEARCH QUESTION

This poses the question; will a contextually appropriate screening instrument provide a tool that can guide the identification of children from low socio-economic communities who are at risk of having sensory integration difficulties?

1.5 PURPOSE OF THE STUDY

The purpose of the study was to develop a low cost, contextually appropriate screening instrument to identify if children between 5 years 0 months to 6 years 11 months, living in low socio-economic areas, are at risk of having sensory integration difficulties. The screening instrument will be appropriate for use by community occupational therapists working in public healthcare settings with only basic knowledge of sensory integration.

1.6 RESEARCH AIMS AND OBJECTIVES

The study was divided into three phases to ensure a systematic process was followed. Phase one, focused on the development of the screening instrument and comprised of the development of the items to measure the sensory integration construct. Phase Two, the operationalisation phase, followed during which the newly developed screening instrument was pilot tested to establish the internal construct validity and clinical utility of the instrument.

Phase Three, was the validation phase and aimed to determine additional psychometric properties of the newly developed instrument.

1.6.1 Aim Phase One

To develop the items for the screening instrument identifying sensory integration difficulties in children aged 5 years 0 months to 6 years 11 months, from low socio-economic environments.

1.6.1.1 Objectives: Phase One

- ❖ To explore and identify the sensory integration activities for inclusion in the sensory integration screening instrument.
- ❖ To obtain consensus on the suggested activities chosen for inclusion in the screening instrument.
- ❖ To construct an administration format and scoring system using activity analysis.
- ❖ To compile an administration manual and clinician training programme to guide administration and scoring of the screening instrument.

1.6.2 Aim Phase Two

To field test, refine and determine the internal construct validity and clinical utility of the newly developed sensory integration screening instrument on children aged 5 years 0 months to 6 years 11 months in low socio-economic environments.

1.6.2.1 Objectives: Phase Two

- ❖ To pilot test the sensory integration screening instrument with children growing up within low socio-economic environments.
- ❖ To establish internal construct validity of the sensory integration screening instrument.
- ❖ To establish the clinical utility of the newly developed sensory integration screening instrument, e.g. appropriateness for use and difficulties with administration and scoring.

1.6.3 Aim Phase Three

To establish additional psychometric properties of the newly developed sensory integration screening instrument.

1.6.3.1 Objectives: Phase Three:

- ❖ To determine the content validity of the sensory integration screening instrument.
- ❖ To establish concurrent validity by comparing the sensory integration screening instrument against the gold standard, the SIPT measurement.
- ❖ To establish sensitivity and specificity of the sensory integration screening instrument.

1.7 SIGNIFICANCE OF THE STUDY

Early detection of developmental difficulties in foundation skills is of critical importance in preventing learning difficulties before the child commences with formal schooling (Richter, 2016). Developmental difficulties, such as sensory integration difficulties, in children from low socio-economic environments are often only identified and referred for occupational therapy services when they start formal schooling at the age of six or seven years. Occupational therapy services within the public healthcare system are experiencing constraints in service delivery due to the availability of appropriate assessments and staff knowledgeable on sensory integration (van Stormbroek and Buchanan, 2016); this results in the inadequate identification of sensory integration problems and inappropriate intervention. The National Department of Health Annual Performance Plan for 2017 aims to improve service delivery with the implementation of the ideal clinic in primary healthcare (National Department of Health, 2017). The establishment of the ideal clinic aims to provide services within communities, to upscale staff and improve resources and equipment such as assessment materials (National Department of Health, 2017). The ideal clinic would be an excellent setting for community service occupational therapists to use a screening instrument developed specifically for children in the South African context. Not only will the screening instrument be cost-effective and easily accessible, it will empower the community service occupational therapist to identify timeously children at risk of having sensory integration difficulties. Proper and timeous identification of sensory integration difficulties in children from low socio-economic areas could encourage appropriate referral or the provision of sensory integration stimulation programmes to address these difficulties. Through appropriate service delivery, the child's difficulties could be timeously addressed and have a positive impact on school participation and academic achievement.

1.8 ORGANISATION OF THE THESIS

The thesis is organised into eight chapters as described below:

Chapter 1: Introduction: presents the introduction to the study, the research question, problem statement, the aims and objectives and the justification for the study.

Chapter 2: The literature review on sensory integration and low socio-economic environments: includes the literature review and focuses on sensory integration and the development of children living in low socio-economic areas.

Chapter 3: The literature review on test development: continues with the review of the literature and focuses on instrument development.

Chapter 4: Underlying philosophy and assumptions: describes the underlying philosophy and assumptions for the methodology used in the study as well as the ethical aspects taken into consideration during the study. This chapter includes the literature appraisal and content analysis to set up criteria for instrument development. These criteria guided the construction of the phases for the study.

Chapter 5: Methodology for the three phases involved in the development of the screening instrument: describes the methodology used for the phases of the study according to the criteria explained in Chapter 4.

Chapter 6: Results for the three phases involved in the development of the screening instrument: covers the research results and reports on the results on a phase-by-phase basis starting with phase one, followed by the results for phase two and concludes with the results for Phase three.

Chapter 7: Discussion: discusses the results and the interpretation thereof, considering the existing literature.

Chapter 8: Conclusion, limitations and recommendations: provides a summary of the study and draws a conclusion to answer the research question. The limitations and final recommendations for implementation and further investigations close this chapter.

CHAPTER 2: THE LITERATURE REVIEW ON SENSORY INTEGRATION AND LOW SOCIO-ECONOMIC ENVIRONMENTS

2.1 INTRODUCTION TO THE LITERATURE REVIEW

Occupational therapists are involved in promoting health and well-being in children by facilitating engagement in occupations within the environments that they live in. The relationship between the child and their context and/or environment forms an essential part in the development of their performance. The environment the child grows up in, is however, not static and several types of environments, such as the observable environment, the social environment and the cultural environment make a contribution (Bronfenbrenner, 2009; Dunn et. al., 1994). Adverse environments, such as living in low socio-economic environments and poverty, can have a destructive influence on all aspects of a child's health and well-being. This is a concern because according to Statistics South Africa (2017), 63% of children in South Africa live in low socio-economic environments. Low socio-economic environments have their own unique challenges, such the physical environment with poor housing and nutrition and poor access to services, the social environment with lack of stimulation and nurturing care of the child and the cultural environment with low levels of parental education (Hall and Sambu, 2017).

Ayres (1972a) proposed that children's interaction with the environment results in the development of appropriate foundational skills, such as sensory, motor, cognitive and behavioural skills. This interaction is based on the neurological process of taking in sensation from the environment, processing it in the central nervous system and generating appropriate learning and behaviour (Ayres, 1972a; 2005). This neurological process is known as sensory integration (Ayres, 1972a; 2005). Lane and Schaaf (2010) presented evidence from animal studies that successful interaction with the environment results in appropriate sensory integration, which in turn facilitate neuroplasticity and optimum brain development. Difficulties in processing and integrating sensations from the environment result in occupational performance difficulties. Koenig and Rudney (2010) reviewed studies on sensory integration and recounted difficulties in occupational areas such as activities of daily living, play, leisure and education. Cermak (2001b) pointed out that adverse environmental aspects, such as poor nutrition, poor social interaction and lack of active environmental exploration, could result in the disruption of sensory integration and resultant normal development. Considering the vital influence of the environment in the processing and integration of sensory input, the limited research done in South Africa has already indicated that children living in low socio-economic environments are in jeopardy of developing sensory integration difficulties (Van Jaarsveld et. al., 2001a; Van Jaarsveld, 2010; Van der Linde and Olivier, 2010).

Sensory integration theory is grounded in several assumptions that explain the influence of the environment on the processing and integration of sensory input. The literature review will investigate possible impact of the adverse determinants of low socio-economic environments in relation to the impact on sensory integration. This will be followed by addressing the controversy regarding evidence on sensory integration theory by clarifying terminology and assessment and intervention practices. The section on sensory integration will be concluded by investigating assessment practices in sensory integration, as well as how sensory integration theory fits within the South African context.

Chapter 3 will review the literature on assessing children from low socio-economic environments and the process that needs to be followed to develop a screening instrument to determine the risk of sensory integration difficulties in children from low socio-economic environments.

2.2 DEFINING THE LOW SOCIO-ECONOMIC ENVIRONMENT

The environment and/or context the child grows up in plays a detrimental role in their development. The Occupational Therapy Practice Framework 3rd Edition (OTPF-3), uses the terms context and environment to refer to the variables that play a role in the participation in activities (AOTA, 2014). The framework describes context as the less tangible variables that surround the person and can be cultural, personal, temporal and virtual (AOTA, 2014). The International Classification of Functioning, Disability, and Health: Children and Youth Version: ICF-CY, define environmental factors as "*all aspects of the external or extrinsic world that form the context of an individual's life and, as such have an impact on that person's functioning*." (World Health Organization, 2007: 229). Environmental factors include several types of environments, such as the physical environment, the natural and build surroundings, the social environment, such as relationships with people, and the cultural environment, for e.g. customs, beliefs and activity choices (AOTA, 2014; Bronfenbrenner, 2009; Dunn et. al., 1994). When the environmental factors are changed or adversely affected, there will be a negative impact on the child's development and occupational engagement (AOTA, 2014). Socio-economic status encompasses all these environments as it includes the physical conditions and area the person lives in, their income or availability of economic resources, level of education, social status and prestige (Abubakar et. al., 2008; Hook et. al., 2013; Miser and Hupp, 2012). Children are classified under the socio-economic status of their parents, as it is not possible to measure their income, educational status or social status.

A low socio-economic status describes an environment with a lack of the above resources and that can have a harmful influence on a child's health and well-being. Bradley and Putnick (2012) proposed that to ensure a child's well-being a parent needs to provide the child with food and healthcare, a safe environment, stimulating and supportive opportunities and materials for learning, socio-emotional support, supervise behaviour and provide social connections. These resources are however not always available within low socio-economic environments and children growing up in these environments are at risk of experiencing developmental difficulties, such as sensory integration difficulties. Low socio-economic status is frequently linked to poverty and child poverty is described by Chaudry and Wimer (2016) as children living within an environment where the income is insufficient to provide for the child's primary needs, social health and well-being. There are disagreements on the definition of poverty as some organisations, such as The World Bank and UNESCO, measure poverty in terms of household income that falls below the threshold of US$1.90 per person per day (World Bank Group, 2016; UNESCO, 2017). Other authors, such as Halfon (2016) and Alkire et. al. (2015), however argue that the ability to meet primary needs, such as a place to live, nourishment, access to water and sanitation, access to primary healthcare and education, need to be considered. As poverty forms a part of the low socio-economic context, in this literature review, and any further discussions, low socio-economic status and poverty will be used interchangeably.

Measurement of poverty in the South African context is, however more complicated than just determining income thresholds and meeting basic needs, due to the diversity and political history of the country. An investigation by Meyer (2016), on poverty in the Northern Free State, found that 68.8% of the study's residents lived under the individual poverty line of R720 per month and that females headed 50% of the households. Unemployment in this study was high with subsequent low-income levels. Not only did the sample population live below the poverty line, but their basic needs were not always met due to inadequate service delivery and substandard access to basic medical services (Meyer, 2016). Corresponding results were found by Steinert et. al. (2016), who investigated a homogenous population within urban and rural communities in KwaZulu-Natal, South Africa. The authors found differences in poverty between urban and rural areas, and suggested that the indicators used may be biased towards rural areas and did not consider aspects such as agricultural income or land ownership. Ward and Shackleton (2016) had a similar argument about the fact that traditional poverty measures do not include the use of natural resources that can alleviate the effect of poverty. Their study found there were differences in poverty between rural, urban and township areas, with higher poverty in townships. Although poverty was found to be high in rural areas, financial strain was alleviated by an additional income from natural resources, such as collecting and selling firewood. The study found differences between the use of spaces (e.g. for agriculture) in different provinces, such as Limpopo and Eastern Cape, within South Africa (Ward and Shackleton, 2016). The researcher's experience from working in these diverse contexts is that it is noticeable that inexperienced occupational therapists do not have a workable knowledge of the risk of low socio-economic environments and poverty on our clients.

Knowledge of the influence of environmental risk factors on child development will enhance occupational therapists' knowledge on assessing and providing intervention for children living in poverty. Occupational therapy services to children living in poverty are provided within the public healthcare system, especially primary healthcare. The focus of primary healthcare clinics is on addressing the social determinants of health. The World Health Organisation (WHO) defines social determinants of health as *"the conditions in which people are born, grow, live, work and age. These circumstances are shaped by the distribution of money, power and resources at global, national and local levels"* (World Health Organization, 2018). In 2015, the United Nations, launched the implementation of seventeen sustainable development goals to address extreme poverty through a wide set of social determinants (United Nations, 2015), which include aspects such as employment, social exclusion, public health, gender equality, early childhood development, globalisation and health systems (United Nations, 2015). The South African National Department of Health described in the Annual Performance Plan for 2017, plans to attend to these social determinants of health through the re-engineering of primary healthcare (National Department of Health, 2017).

The focus during the re-engineering of primary healthcare will be to shift from health outcomes to addressing the underlying factors, e.g. decrease maternal and child mortality, provide nutritional assistance, prevent infectious diseases, poor quality childhood care and better access to services (National Department of Health, 2017). The aim is further to establish ideal clinics within the communities with knowledgeable staff that will deliver services to families and children. The social determinants of health include the environmental risk factors that influence a child's development such as financial and material hardship, increased stress for children and parents, parenting difficulties, inadequate housing, poor parental education and health, as well as substandard education and schooling (Duncan et. al., 2012). Early childhood development is one of the important social determinants of healthcare, as it includes aspects such as a child's physical, cognitive, language and socio-emotional wellbeing.

One of the approaches occupational therapists use for assessment and intervention is based on the theory of sensory integration. As sensory integration theory considers the interaction of the person within their environment, it makes this theory ideal to address developmental difficulties within a child's specific environment (Smith Roley et. al., 2001a).

2.3 INTRODUCTION TO SENSORY INTEGRATION THEORY

Dr Jean Ayres established the theory of sensory integration to explain children's learning and behaviours, as she believed that the processing of sensory information in the central nervous system (CNS) influenced development (Ayres, 1972a; 2005). The accurate processing of sensory input provides the foundation for participation in occupation. Ayres (1972a) proposed that children experience and learn about their environment through sensations such as touch, auditory, smell, and vision from outside the body, and gustatory, vestibular and proprioception from within the body. These sensations are processed and integrated within the CNS and results in the development of motor skills, social and emotional skills, and successful participation in occupations (Smith Roley et. al., 2001a). The outcome of the processing of sensory input from the environment results in two types of sensory integration functions, sensory reactivity and sensory perception (Schaaf and Mailloux, 2015). Sensory reactivity is described as a behavioural outcome of sensory integration and indicates the child's ability to regulate and react to sensory information from the environment, e.g. being over-responsive or under-responsive to sensory input (Schaaf and Mailloux, 2015). Over-responsivity describes a child's exaggerated or inappropriate responses to non-threatening input, whereas under-responsivity relates to low levels of arousal, e.g. resulting in diminished activity levels (Schaaf and Mailloux, 2015). Sensory perception, however, focuses on determining the quality of sensory input to provide meaning to it, rather than the intensity of the sensory input, for e.g. determining the shape or size of and object (Schaaf and Mailloux, 2015).

Various assumptions or core concepts underpin the theory of sensory integration and focus on the organisation of sensory input from the environment as an important aspect of development. The theory of sensory integration explains the difficulties children experience, the assessment thereof, as well as guiding the intervention process. The assumptions of the theory of sensory integration, which explain the interaction of the child's senses with the environment and how neuronal pathways are developed to facilitate complex actions in response to the environment, will be discussed in the next section.

2.3.1 Sensory integration as an important foundation for learning and behaviour

The first assumption of the theory of sensory integration includes the argument that the processing and integration of sensory information underpins all learning as up to the age of seven, children learn primarily through the interaction of body senses, such as vestibular, proprioceptive and tactile senses (Ayres, 1972a; 2005). Ayres (2005) proposed that these three systems play a foundational role in the processing of sensation in other sensory systems.

Vestibular input is detected through the semi-circular canals and the otolith organs in the inner ear and play a role in sensory perception as well as sensory reactivity (Ayres, 1972a; 2005). Sensory perception in the vestibular system contributes to the detection of head movement in a three-dimensional space, generating a spatial map of the body as related to self and the world (Ayres, 2005; Pfeiffer et. al., 2014). Functionally, the accurate processing of vestibular input was found to support, among other things, postural reactions, spatial orientation and stabilisation of the gaze (Kreivinienė, 2016; Lane, 2002b; Pfeiffer et. al., 2014). On a performance level, the vestibular system was found to play a role in language acquisition and cognitive skills, such as spatial memory and learning. Early studies by Ayres and Mailloux (1981) and Magrun et. al. (1981) found a possible link between vestibular input and difficulties in language and academic skills, although there is still no conclusive research evidence on this. Hitier et. al. (2014) investigated the effect of vestibular pathways in the development of cognitive skills. The researchers alluded to the fact that the vestibular system plays a role in memory, spatial navigation and learning, resulting in difficulties with reading, writing and numeracy (Hitier et. al., 2014). Apart from the vestibular pathways involved in sensory perception, the vestibular system was found to have links with the limbic system (Ayres, 1972a; 2005; Lane, 2002b). This link could possibly explain the vestibular system's involvement in the autonomic nervous system reactions to movement, manifesting as sensory reactivity, e.g. an aversion to movement (Ayres, 2005). In the literature, sensory reactivity within the vestibular system was associated with disorders such as anxiety and depression (Smith and Zheng, 2013). Processing of vestibular input is frequently linked to proprioceptive input and similarly plays a role in sensory integration (Ayres, 1972a; 2005).

Proprioception is described as the perception of one's movement in space based on the feedback from joint and body movements (Ayres, 1972a; 2005). Proprioception, in collaboration with the vestibular system plays a role in the development of body position in space (Ayres, 1972a; 2005). Lane (2002b) explains that the proprioceptive system is essential in providing information on the orientation of the body, the force used during movement as well as the timing of the movement. Functionally, proprioceptive input plays a role in body scheme, or the map the body has of itself within the environment, and influences the ability to motor plan movements (Smith Roley et. al., 2007). The close connection between proprioceptive input and vestibular input were found to play a role in bilateral integration and sequencing skills. A recent verification of sensory integration dysfunctions, by Mailloux et. al. (2011), again confirmed that vestibular and proprioceptive input are associated with bilateral integration and sequencing patterns. Anatomically, the proprioceptive system is further linked to the tactile system through shared pathways known as somatosensory pathways.

The tactile system is a major contributor to gathering information from the environment and influences both tactile reactivity and tactile perception. Deficient tactile perception includes experiencing challenges in detecting spatial aspects of an object, such as the shape of the object or the size of the object (Ayres, 2005). Factor and cluster analysis determined that tactile perception influences praxis and consequently links to the sensory integration dysfunction of somatodyspraxia (Mailloux et. al., 2011). Tactile reactivity influences the child's ability to self-regulate and maintain an optimum level of arousal (Smith Roley et. al., 2007). Mailloux et. al. (2011) confirmed, with factor analysis, tactile defensiveness as a sensory integration dysfunction that results in behavioural difficulties, hyperactivity and the inability to concentrate.

The proprioceptive, vestibular and tactile systems are the body-centred systems that integrate with the visual and auditory system to play a role in academic skills such as reading, writing and maths (Smith Roley et. al., 2007). Although each sensory system contributes to sensory integration, no system works in isolation and the ability to successfully process and integrate sensory information is essential to form more complex learning and behaviours described as end-products, such as academic skills and reading and writing (Schaaf and Mailloux, 2015).

2.3.2 Sensory integration follows a developmental sequence

The second assumption is that sensory integration follows a developmental sequence where each area of development becomes more complex as the child develops (Ayres, 2005). Ayres (2005) described this developmental sequencing as building blocks, where mastery of one experience builds on the next. The first three years of a child's life is important for the development of cognitive, social and motor skills (Jacobs and Schneider, 2001; Richter et. al., 2017). Ayres (1972a) and Cermak (2001b) pointed out that adverse environments could result in the disruption of sensory integration and resultant normal development. Not only do these aspects play a role in sensory integration, they are frequently observed in papers on the unfavourable influence of poverty on child development.

Lack of nutrition is one of the social determinants of health frequently encountered in low socio-environments, worldwide and in South Africa. Malnutrition results in growth restrictions, stunting, iodine deficiency, elevated levels of anaemia and exposure to toxin. (Ford and Stein, 2015). Deficient nutrition was found to affect the development of motor skills, as well as cognitive potential, such as executive functioning. This pronouncement was confirmed by Abubakar et. al. (2008), who found in a study in Kenya that there was a meaningful relationship between nutrition and motor skills. Malnutrition were found to result in inadequate energy resources needed for exploring the environment and cognitive development (McCoy et. al., 2015b).

Nutrition from a sensory integration viewpoint however is not due to lack of food, but rather the child's difficulty to process oral or tactile sensory input resulting in over-reactivity to specific food tastes and textures (Nederkoorn et. al., 2015). This could result in similar deficiencies because the child is not receiving the appropriate nutrients.

The lack of nurturing care and poor parenting practices are environmental risk factors that similarly influence the child's development, specifically related to their cognitive abilities and language development (McCoy et. al., 2015a). Nurturing care is described by Britto et. al. (2017) as the availability of an environment that is sensitive to a child's health and nutrition, that protects against threats and provides opportunities for learning and interaction. The importance of nurturing care was emphasised by Ayres (2005) as contributing to the child's developmental sequence. She proposed that the early interaction of the infant with nurturing caregivers, through touch or social interaction, results in the appropriate neuronal processing and integration of sensory input (Ayres, 2005). The neuronal processing and integration of sensory input develop in the building of higher order motor activities and emotional regulation (Ayres, 2005). Nurturing care and harsh parental interaction within low socio-economic environments were however found to be troublesome. McCoy et. al. (2015a) reported that harsh parenting undermined the child's ability to develop adaptive behaviour and relevant emotional skills. Sharkins et. al. (2017) similarly described a strong relationship between poor parenting skills and internalising behaviours in children and proposed that this was due to less opportunities provided by a parent to practice self-regulatory skills. The mother's ability to provide nurturing care in a low socio-economic environment was negatively influenced by the mother's level of education. The educational level of the mother was especially associated with higher cognitive levels, language and that the mother saw the value of investing in books and stimulating materials (Piccolo et. al., 2016a).

The fact that parents in low socio-economic environments are frequently illiterate could play a role in limited language proficiency on the parents part (Naudé et. al., 2003). Hirsh-Pasek et. al. (2015) further found that not only did poverty affect the quantity of words learned from the mother, but also the quality of the language. The words introduced by a parent in a shared activity allow the child to learn about the meaning of the word, and for practice of the word. Maternal depression was mentioned as another factor that influences the child's potential to self-regulate (Sharkins et. al., 2017). The authors hypothesised that a mother's lack of positive behaviour towards a child, caused an increase of negative emotions (Sharkins et. al., 2017). The lack of nurturing care and limited opportunities to learn in low socio-economic environments precipitated difficulties with executive functioning, working memory and especially inhibitory control or the ability to regulate attention and behaviour (Cockcroft et. al., 2015).

Although Ayres (2005) alluded to the influence of nurturing care on the sensory integration building blocks involved in the developmental sequence, no research could be found in sensory integration focusing on this topic.

Another area of nurturing care that influences the developmental sequence is the availability of safe and stimulating environments with resources such as books, educational toys and other toys. The literature on child development in low-socio economic environments emphasises the impact of a stimulating environment and the availability of books, toys and stimulation on especially cognitive development (Ford and Stein, 2015; McCoy et. al., 2015b; Piccolo et. al., 2016b). In a cross-sectional study on 2837 children in China, Wei et. al. (2015) found that having no learning resources, such as children's books, toys and a supportive learning environment, were predictive of poor child development. It was found that families with a low income would rather spend funds on obtaining food, thus less likely to invest in books or stimulating material (Piccolo et. al., 2016b; Ursache and Noble, 2016). The literature on sensory integration recounted similar findings, as the exploration and interaction with stimulating environments help children to master tasks (Cermak, 2001b). As children have an inherent drive to engage with their environment, the availability of stimulating environments are particularly important (Ayres, 2005).

2.3.3 Sensory integration involves the child's innate drive to explore their environment resulting in adaptive responses

Ayres (2005) theorised that children are internally motivated to explore and interact with their environment, and that when the environmental demands are just right for challenging the child's skills set, the child will make adaptive responses to build new skills and abilities. The child's drive to explore their environment and facilitating successful adaptive responses to the changes in the environment, are two key aspects in sensory integration intervention (Schaaf and Mailloux, 2015). The child's motivation to actively participate successfully in the environment, could however be hampered by engaging in threatening environments or those that cause stress and anxiety. Low socio-economic environments present with higher risks of threatening factors such as crime, violence, pollution, health risks and chronic stress (Chaudry and Wimer, 2016). The potential of engaging in just the right challenge and develop adaptive responses to the environment is however negatively influenced. Children may be too scared to explore their environment or may be exposed to health risks in doing so. Ineffectiveness in adapting appropriately to these environmental demands were seen in this population's presenting emotional difficulties. Raver et. al. (2015) found evidence of children developing emotions such as fear, anxiety and sadness when growing up in threatening environments.

The study by Raver et. al. (2015) investigated the impact of environmental threats on the emotional development of 1025 children aged between 6 and 8 years.

The results indicated that children faced with chronic feelings of being unsafe and living in high conflict households might show disruption in their ability to modulate their emotions.

These children had difficulty encoding, organising and recovering emotional information and their extended exposure to environmental threats affected their physiological ability to modulate their mood states. Consequently, they lived in a constant state of high arousal that influenced their level of reactivity (Raver et. al., 2015). This constant level of high arousal provides some explanation for the elevated levels of stress these children experienced.

Bar-Shalita et. al. (2008) linked consistent exposure to stressful events with ineffective activation of the autonomic nervous system, resulting in the inability to adapt successfully to altering stimuli. The parasympathetic system plays a role in returning the body to a regulated state of arousal, whereas the sympathetic system modulates the fright, fight or flight reaction (Schaaf et. al., 2003). Over activity of the sympathetic system resulted in over-reactivity to stimuli and was further linked with increased cortisol levels and anxiety. Piccolo et. al. (2016b) conducted a study where the researchers measured the child's reactivity to stress by assessing their salivatory cortisol levels before and after an assessment battery. The results showed the more dysfunctional the home environment was, the higher the cortisol levels were after the participation in the assessment battery (Piccolo et. al., 2016b). The researcher's further argued there was a relationship between stress and memory, as the higher the child's stress levels, the weaker their memory was, and the more difficulty they had retrieving information from memory (Piccolo et. al., 2016b). A literature review by Duncan et. al. (2017) confirmed the evidence of chronic stress in children, which showed increased levels of cortisol that influenced the areas of the brain activated for self-regulation.

Environmental threats, as well as lack of parental care and stimulation, were seen as the most powerful stressors in a child's life (Loman and Gunnar, 2010). Interestingly, parenting was similarly influenced by environmental stress. Parental stress was linked with insensitive, harsh parenting, punitive over controlling parental behaviour, spending less time interacting with the child, as well as heightened child abuse (Masarik and Conger, 2017). The child was found to experience withdrawal of support and affection and there was less time to engage in social and cognitive enrichment activities. The influence of parental stress on the child's ability to react to the challenges from the environment and sensory integration patterns have not yet been investigated. Parents with children experiencing sensory integration difficulties were reported by Gourley et. al. (2013) to have elevated levels of stress than parents with typical children. The findings indicated that the stress levels of these parents increased with the severity of the sensory integration difficulty.

Another risk factor of poverty with a related influence on self-regulation and the ability to adapt to the environment is known as chaotic homes or household chaos. This household is characterised by noisy, overcrowded houses, with lack of discipline and routine, unpredictability and even frequent changes in the family structure (Chaudry and Wimer, 2016; Garrett-Peters et. al., 2016). Opportunity to engage in a 'just right challenge' in such a disruptive environment is questionable.

A study by Garrett-Peters et. al. (2016) into the influence of household chaos on the child's development, found that academic achievement was especially affected. The children have fewer opportunities to develop their regulatory systems due to the frequent moves and changes of the environment, excessive noise and the ability to focus on academic activities. The authors proposed that due to the difficulties to develop their regulatory system they may find it difficult to adapt to the environment resulting in blocking out the environment or withdrawing from all the stimulation (Garrett-Peters et. al., 2016). This type of household is not conducive to exploration and learning and may have a profound influence on the child's ability to learn adaptability to environmental changes. This inability of the child to regulate their system and to adapt to the environment speaks of the child's difficulty with sensory integration and their poor adaptive responses in terms of under-reactivity to sensory input.

2.3.4 Sensory integration is dependent on neuroplasticity

An important assumption of the theory of sensory integration is that underlying neuronal processes within the central nervous system involved in neuroplasticity influences the child's ability to respond to the requirements of the environment (Ayres, 1972a; 2005). Neuroplasticity is defined by Voss et. al. (2017: 1) as "the brain's ability to modify, change and adapt both structure and function throughout life and in response to experience." This neuronal process is consequently responsible for the changes in the brain fostered by interaction with the environment and the resultant adaptive response. Environmental influences on neuroplasticity is thus a key factor to investigate not only in sensory integration theory, but also in the development of children growing up in low socio-economic environments. Studies on neuroplasticity in child development emphasises that early periods of development are the most sensitive to neuroplasticity, specifically to the processing of sensory information (Blair and Raver, 2016; Inguaggiato et. al., 2017; Johnson et. al., 2016; Takesian and Hensch, 2013). Takesian and Hensch (2013) reported that the early developmental period is important to establish an optimum map of the environment and for the proper myelination in the prefrontal cortex. This period of maturation is essential to the complex developmental system involved in sensory and cognitive functions (Inguaggiato et. al., 2017).

Adverse environments, such as low socio-economic environments, can influence the neuronal processes in the brain, causing difficulties in processing and integrating sensory information, resulting in neuronal pathways or brain structures (Ayres, 1972a; 2005; Inguaggiato et. al., 2017). Brain imaging on children from low socio-economic environments indicated changes to brain structures in the prefrontal cortex, hippocampus and amygdala (Clemenson et. al., 2015; Katsnelson, 2015). Ayres (1972a) believed that learning and behaviour problems could be associated with difficulty in the organisation of sensory information in the CNS, rather than being due to specific CNS damage or abnormalities. Lane and Schaaf (2010) investigated this assumption by doing an evidence-based review of the literature on neuroplasticity and learning in sensory integration. Although the literature review mostly covered studies conducted on animals, the results supported Ayres' hypothesis that improved processing of sensory information impacts on neuroplasticity, and that the ability of the brain to change provides building blocks for learning (Ayres, 1972a; 2005). Animal and human studies found evidence of the influence of the environment on neuroplasticity in sensory integration theory and development in low socio-economic areas.

2.3.4.1 The neurological impact of the environment on sensory integration explained through animal studies

Lane and Schaaf (2010) stated the scientific basis of sensory integration theory is rooted in animal research, and that it is, therefore, necessary to investigate animal, as well as human, studies in examining brain plasticity. Animal studies can provide advantageous information on the processing of sensory input within several types of environments, as well as the resultant influence on brain development. Similarities between humans and non-human primates regarding physiological, biological and neurological characteristics are cited as reasons for applying results of research on primates to humans (Perretta, 2009). Primate studies are ideal to investigate the influence of brain function on learning and behaviour in a controlled environment, and the ability to assign subjects randomly as a positive aspect in improving the rigour of the study (Schneider et. al., 2011).

Animal studies on the impact of the environment reported on the influence of environmental risk factors such as deprived or isolated environments, nurturing parenting, nutrition and stress. Lack of nurturing behaviour from the caregiver was found to influence complex social behaviour in rat pup studies and primate models (Inguaggiato et. al., 2017). Lipina and Posner (2012) observed corresponding results with rodents in isolated environments. The rodents showed less interaction, displaying increased psychomotor behaviour and resulting changes in the frontal, parietal, hippocampus and cerebellar areas of the brain (Lipina and Posner, 2012).

Takesian and Hensch (2013) reported similar findings in mouse pups after two weeks of isolation, with resultant difficulties in prefrontal cortex behaviours. The isolated environments and lack of maternal input were found to increase the stress levels and corticosterone/cortisol increase (Blair and Raver, 2016). Increased levels of stress in animals, resulted in a disruption of the hypothalamus–pituitary–adrenal (HPA) system, which in turn affected the neuro-circuitry of the brain (Inguaggiato et. al., 2017).

Investigations into the evidence of the influence of the environment, such as deprived environments and the mother's behaviour on neuroplasticity and the ability to process and integrate sensory input described very similar results. A literature review directed by Lane and Schaaf (2010) investigated the neurological impact of the environment on brain plasticity and how this could be related to sensory integration. Level I, high quality randomised control trial studies (RCT), using animal models, found that the environment facilitated neurological changes in the animals. The results of these studies illustrated that the exploration of the environment needed to be active and internally driven for optimum brain plasticity. These findings are similar to Ayres (1972a) view that the 'just right challenge' and the child's innate drive to explore their environment facilitate sensory integration and optimum brain CNS development. Various animal models were used in the above studies, e.g., rodents, rhesus monkeys and cats, with similar findings, proposing that the results were species specific and not animal specific (Lane and Schaaf, 2010). These findings alluded to the belief that results can be generalised to humans.

Further findings on Level II studies, lesser quality RCT and prospective comparative studies, showed that the successful interaction with the environment promoted brain plasticity. This could be seen in the aptness of the brain to alter the way sensory information is processed in a different sensory system if another system is compromised (Lane and Schaaf, 2010). This shows the ability of the brain to recruit other sensory systems to process information from the environment if one sensory system is affected. Lane and Schaaf (2010) described various level III, IV, V non-randomised studies, single subject or case design studies that found changes in brain organisation, when the environment did not provide adequate sensory information. These studies indicated there are critical periods for development that are sensitive to deprived environments. This literature review suggested that neuroplasticity is influenced by the interaction of the sensory systems with the environment resulting in changes to brain structures (Lane and Schaaf, 2010). The authors suggested the animal studies confirmed the theoretical underpinning of sensory integration, stating that active engagement in sensory activities that provide the 'just right challenge' will result in changes in the central nervous system (Lane and Schaaf, 2010).

Other animal studies on sensory integration and the influence of the environment on brain development were conducted by Schneider et. al. (2009), Schneider et. al. (2008) and Schneider et. al. (2007).

All three studies investigated the influence of the prenatal environment and the exposure of the offspring to the mother's alcohol consumption and stress using monkeys. These studies found that monkeys subjected to alcohol and stress prenatally showed disrupted sensory integration resulting in over-responsiveness to repeated tactile input, instead of habituating to the input or withdrawal from the input.

Further results indicated that prenatal exposure to alcohol and stress alters the neurobiology within the brain, affecting the behavioural responsivity of the monkeys (Schneider et. al., 2009; Schneider et. al., 2008; Schneider et. al., 2007). The above-mentioned research presented evidence that successful interaction with the environment result in appropriate sensory integration, which in turn facilitate neuroplasticity and optimum brain development. Despite these findings, the results need to be considered with care as the application of animal studies to human behaviour is still controversial and may influence the validity of the findings discussed above. However, similarities of findings between human and animal models are common and will be discussed in the next section.

2.3.4.2 The neurological impact of the environment on sensory integration explained through human studies

Animal studies provided interesting results on the neurological underpinnings of living in low socio-economic environments and sensory integration. Human studies investigated similar aspects of the environment's influence on neuroplasticity.

Investigations into the influence of low socio-economic environments on neuroplasticity in humans found similar results to animal models. Changes to grey matter, especially in the frontal and temporal cortex and the hippocampus, were frequently observed (Blair and Raver, 2016; Britto et. al., 2017; Lipina and Posner, 2012; Ursache and Noble, 2016). Blair and Raver (2016) discussed a study of 389 children, between the ages of 4 and 22 years, living in poverty and provided evidence of reduced grey matter volume in the above-mentioned areas. Noble et. al. (2015) studied more than a 1000 magnetic resonance imaging (MRI) scans of participants between 3 and 20 years and detected similar differences in the cerebral cortex as well as reduced hippocampal volume. Key environmental risk factors contributing to these brain changes included deprived environments that lack stimulation, poor mother child interactions, nutrition and chronic stress (Blair and Raver, 2016; Noble et. al., 2015; Ursache and Noble, 2016).

Similar to animal studies evidence was found in human models of the effect of chronic stress on neuroplasticity. The HPA axis system in conjunction with the sympathetic nervous system is triggered by stress responses resulting in the increased levels of cortisol and the fight or flight response (Ursache and Noble, 2016). Continuous exposure to stress presented changes to the neurobiological systems involved with dysregulation of the HPA system, with functional influences on executive functioning and emotional regulation (Blair et. al., 2013).

Difficulties in the processing and integration of sensory input from the environment manifest in similar ways. Multiple human studies were done to establish the neurological ground for sensory integration, using non-invasive techniques, such as MRI, electroencephalogram (EEG), and electro-dermal stimulation. Chang et. al. (2015) and Owen et. al. (2013) used diffusion tensor imaging (DTI) and the Sensory Profile by Dunn (1999) to investigate the difference in white matter integrity between children with sensory processing disorder (SPD) and typical children. Their findings indicated that children with SPD had reduced white matter microstructure integrity in the primary posterior cerebral tracts, which correlated significantly with parent reports and direct assessment of sensory processing difficulties (Chang et. al., 2015; Owen et. al., 2013). Chang et. al. (2015) also found notable correlations between white matter microstructure and reduced tactile and auditory processing.

Six studies used EEG technology to find differences in brain activity and behavioural manifestations, between typically developing children and children with SPD (Gavin et. al., 2011; Brett-Green et. al., 2010; Davies and Tucker, 2010; Davies et. al., 2009; Brett-Green et. al., 2008; Davies and Gavin, 2007). The EEG was used because it provided information on direct brain activity in real time and the results could be correlated with the behavioural manifestations of SPD. By measuring the amplitude (the change in voltage following a stimulation) and the latency (the time lapse between the stimulation and the reaction) of the EEG graph, objective measures of neural activity were obtained (Gavin et. al., 2011; Davies et. al., 2010).

Other researchers scrutinised the influence of the autonomic nervous system (ANS) on sensory integration. They proposed that the sympathetic and parasympathetic systems were involved in sensory over and under-responsive behaviour (Schaaf et. al., 2010a; Schaaf et. al., 2003; Boccia and Roberts, 2000; Miller et. al., 1999; Porges, 1996). As the ANS contributes to self-regulation and the ability to maintain homeostasis, researchers suspected that disturbances in the ANS could explain over and under-responsiveness to stimuli. McIntosh et. al. (1999b) and Miller et. al. (1999) focused on the reactivity in the sympathetic nervous system between typical children and those with Sensory Modulation Disorder (SMD). The study measured the influence of electro dermal reactivity experienced by a child while doing a Sensory Challenge Protocol, which provided a variety of sensory stimuli in a set way.

The electro dermal responses were measured by taking the change in the electrical conductance of the skin through the measurement of eccrine sweat gland activity. Both studies found that children with SMD were more reactive to the sensory stimuli and they habituated slower to repeated stimuli (Miller et. al., 2001; McIntosh et. al., 1999b; Miller et. al., 1999). Schaaf et. al. (2003) however described the parasympathetic system as a more valid measure of self-regulation. Two studies on the parasympathetic system were conducted, using the same standardised Sensory Challenge Protocol, but instead measured vagal tone rather than electro dermal reactivity (Schaaf et. al., 2010a; Schaaf et. al., 2003). The findings indicated that children with SMD have compromised parasympathetic systems, which influence their ability to self-regulate and to adapt to the challenges of the environment (Schaaf et. al., 2010a; Schaaf et. al., 2003). A major concern about these studies is that there were some methodological weaknesses, such as small samples, heterogeneous groups and different measurement tools.

These human studies provided valuable evidence of CNS involvement and significant differences in brain function, as well as observable function and behaviour manifestations of sensory integration difficulties. Evaluating the evidence from animal models as well as human studies, the research appears to support the assumption that the appropriate integration of sensory input from the environment result in neuroplasticity and the development of the brain. This successful interaction with the environment and development of neurological processes enables the child to participate in activities (Kramer and Hinojosa, 2010).

2.3.5. Sensory integration as an important foundation for occupational performance.

Ayres (1972a) proposed that children have a natural motivation for exploring and interacting with their environments, using the sensory input they receive as the foundation of participation in occupations. A considerable amount of literature was published on the influence of sensory integration in occupations such as activities of daily living (ADL), play, social interaction, sleep and academic performance. Koenig and Rudney (2010) did a systematic review of studies published between 1986 and 2007, investigating the performance barriers experienced by children and adolescents with sensory integration difficulties. The results of this review confirmed Ayres' hypothesis that children with sensory dysfunctions experience participation limitations in all occupations. Since 2011, more studies were conducted to confirm the link between sensory integration and difficulties with participating in occupations. The child's developmental skills and participation in activities are frequently influenced by low socio-economic environmental risk factors. Similarities were found in the areas of participation that were affected between children with sensory integration difficulties and developmental difficulties due to poverty.

2.3.5.1 Difficulties observed in activities of daily living

Participation in activities of daily living was found by Koenig and Rudney (2010) to be an area of difficulty for children with sensory integration difficulties. In a study by Armstrong et. al. (2013), the Paediatric Evaluation of Disability Inventory (PEDI) was used to determine difficulties in activities of daily living, as well as the amount of assistance that was needed to complete a task. The study discovered that children with sensory integration difficulties performed poorer and required more assistance with self-care tasks, compared to typically developing children. The problems with toileting due to tactile defensiveness, were described in a study by Bellefeuille et. al. (2013). Another study by Elbasan et. al. (2012) used the Ayres' Southern California Sensory Integration Tests (SIPT) and the WEEFIM® to measure participation, in a sample of nine to 10-year-old children with developmental coordination disorder (DCD), compared to a typical sample. The results suggested difficulties in the processing of visual, tactile and proprioceptive input that is needed for ADLs. Minimum difficulties in the ADLs were found and suggested that problems are seen more frequently in children below eight years (Elbasan et. al., 2012). Nederkoorn et al. (2005) conveyed a study on eating activities and found evidence of it being affected by sensory integration difficulties. They found children with tactile over-responsiveness can result in 'picky eaters' as they dislike food consisting of certain textures. A South African study by Smith et. al. (2005) investigated the type and incidence of food eaten by children with tactile defensiveness or tactile over-responsiveness and found these children had limited food choices and aversion to certain food textures or consistencies. Zobel-Lachiusa et. al. (2015) and Cermak et. al. (2014) described similar findings concerning sensory sensitivity and 'picky eating' in children with autism. A study by (Chen, 2014) further related oral processing to the motor planning and motor execution during the process of chewing, rather than sensory sensitivity.

No research studies could be found on the influence of poverty on the execution of activities of daily living. Nutritional issues were explored as a risk factor, but it involved the availability of food and nutrients rather than the influence of sensory reactivity on the feeding of children.

2.3.5.2 Difficulties observed in participating in play activities

Difficulties in processing and integrating sensory input contributes to the child's ability to play. A systematic review of the literature on the influence of sensory integration of play by Watts et. al. (2014), found that there was a delay in the level of play, the children engaged in. Children with sensory integration difficulties were found to engage in less complicated play, social play and even used less time to engage with toys and objects (Watts et. al., 2014). The possible relationship between children's play preference and parent's sensory and play preference were investigated by Welters-Davis and Lawson (2011).

The study set out to determine if this relationship might affect the ‘play with what’ of child-parent play. No specific relationship was found and the results proved to be inconclusive (Welters-Davis and Lawson, 2011). Ismael et. al. (2015) found that children choose leisure activities according to their sensory integration patterns yet could not find significant proof that children with a specific sensory integration pattern only choose specific activities. These sensory integration patterns are based on four patterns, namely low registration, sensory seeking, sensory sensitive and sensory avoiding, as identified by the Sensory Profile (SP) (Dunn, 1999).

Findings by Engel-Yeger and Ziv-On (2011) showed that children with attention deficit hyperactivity disorder (ADHD), and sensory integration difficulties, chose activities according to their sensory integration pattern. The children with ADHD showed a low preference for social participation that correlated positively with auditory and visual sensitivity and low auditory processing. The results further indicated in this population there was a correlation between sensory seeking sensory patterns and an increased preference for physical leisure activities (Engel-Yeger and Ziv-On, 2011). The investigation of the above-mentioned research studies provides provisional evidence of the core concept that sensory integration has an influence on occupational performance. Data on the influence of sensory integration on occupational performance in different settings, such as low socio-economic environments, are however lacking.

2.3.5.3 Difficulties observed in socio-emotional outcomes and behaviour

Difficulty in processing and integrating sensory processing can result in social, emotional and behavioural problems. These outcomes are especially seen in children having difficulty with the regulation of incoming sensory input or sensory reactivity, as referred to by some of the literature. Sensory reactivity is described as a behavioural outcome of sensory integration and indicates the child’s ability to regulate and react to sensory information from the environment, e.g. being over-responsive or under-responsive to input (Lane, 2002a). Ayres (1972a) linked the inability to modulate sensory information with behaviours such as anxiety and distractibility. Behaviours such as disorganisation, distractibility and poor impulse control, as well as mental health difficulties, such as anxiety, depression and lability, are frequently observed in difficulties with sensory reactivity (Miller et. al., 2001). A link was found between sensory reactivity and anxiety, especially in over-reactivity to sensory input that is experienced as a threat (Pfeiffer, 2012; Wallis et. al., 2017). Dunn et. al. (2016) describe similar findings from 29 articles related to these behaviours and emotions in a scoping review on the sensory factors that influences a child’s life.

A study by Reynolds and Lane (2009) on the link between sensory over-reactivity, anxiety and ADHD confirmed associations between sensory over-reactivity and anxiety, as well as higher levels of anxiety in children with ADHD. The researchers found that children with sensory over-reactivity and ADHD displayed similar physiological reactions to anxiety, such as increased heart rate, increased respiration and reduction in appetite (Reynolds and Lane, 2009). Functional outcomes of behaviour were further associated with the environmental experiences of the child and the ability to modulate the input from the senses (Reynolds and Lane, 2009). The link between sensory over-responsivity and socio-emotional skills in children from low socio-economic environments was documented by Ben-Sasson et. al. (2009).

Likewise, living in low socio-economic environments increases the child's risk of having sensory reactivity difficulties and mental health problems. Children are at a higher risk to develop mental health difficulties, such as internalising behaviours, that include anxiety, depression or feeling fearful, as well as externalising behaviours such as aggression and hyperactivity. In the United States, a study by Hetzner et. al. (2010) discovered increased levels of anxiety and depression in this population that is higher than in children living in high socio-economic environments. This study further described associations between long-term poverty, increased emotional difficulties and behavioural problems, such as hyperactivity and being headstrong (Hetzner et. al., 2010). Raver et. al. (2015) conducted a similar study in the United States on 1025 children aged between 6 and 58 months to investigate the influence of environmental threats on emotional development. This study confirmed that children faced with chronic feelings of being unsafe and living in high conflict households might show delays in handling their emotions. These children had difficulty interpreting, organising and retrieving emotional information. Being exposed to prolonged environmental threats affected their physiological ability to modulate their mood states resulting in living in a constant state of high arousal influencing their level of reactivity (Raver et. al., 2015). Raver et. al. (2015) findings regarding the child being able to modulate their mood states are related to behaviours observed in sensory integration when a child is having difficulty with sensory reactivity. Very little research is however available on the link between low socio-economic environments, mental health and sensory integration difficulties in children. Despite the limited research available, the behaviours observed in children with sensory integration difficulties and mental health difficulties are very similar. This poses the question, are children with mental health difficulties experiencing challenges in processing and integrating sensory information.

In addition to emotional and mental health difficulties linked to sensory reactivity and growing up in low socio-economic environment, a further link was found in the development of social skills and participation. Cosbey et. al. (2010) described social skills such as peer interaction and acceptance, engaging in verbal and non-verbal behaviours, interacting with other children while playing and socially appropriate behaviour.

The authors proposed that these behaviours could be influenced by factors such as poor cognitive and communication skills and poor self-regulation. Cosbey et. al. (2010) investigated the difference in social participation between typical children and children with sensory integration difficulties.

The authors were unable to find significant differences between the two groups. Qualitative investigation of the data did however indicate that the context the child lives in, family variables and cognitive and communication skills may negatively influence the social participation of children with sensory integration difficulties (Cosbey et. al., 2010). Conversely, Koenig and Rudney (2010) found, in a systematic review of participation difficulties in children with sensory integration challenges, that social skills are frequently influenced by sensory reactivity.

Correlations were found between sensory reactivity, especially over-reactivity and social competence with play skills that are impacted (Koenig and Rudney, 2010). Similar findings were reported by Ben-Sasson et. al. (2009), who also found links between poor social participation and increased sensory over-reactivity. Additionally, the authors found that children living in low socio-economic environments are more prone to display sensory over-reactive behaviour that results in social participation difficulties (Ben-Sasson et. al., 2009).

Evans et. al. (2005) suggested the chaos found in households in low socio-economic environments plays a role in the development of sensory reactivity and social skills. Within these households children are frequently exposed to unstructured, unpredictable and crowded houses, unresponsive caregivers, with poor bonding and attachment and stressful unsafe restricting social adjustment (Evans et. al., 2005; Jamieson et. al., 2017). Very little research is available on the influence of the environment on social skills and sensory integration skills. One study was found on the predictors of social skills and sensory processing as a variable (Rybski, 2014). This study found a strong correlation between social skills and sensory processing in children from low socio-economic environments. The author further proposed, similar to Evans et. al. (2005) findings, that household disruptions and stressful events impact on the sensory processing and social skill development in children from low socio-economic environments (Rybski, 2014). More research is needed to investigate the link between sensory integration difficulties and social skill development within the field of child development and poverty.

2.3.5.4 Difficulties observed in academic performance

Academic achievement is dependent on the culmination of all cognitive, language, socio-emotional and motor skills. In low socio-economic environments, where all these areas of development are affected, poor academic achievement could be suspected.

Sensory integration difficulties can also influence academic achievement. In a four year longitudinal study, Parham (1998) set out to determine the relationship between sensory integration difficulties and academic achievement. The study used SIPT scores as the independent variables to determine relationships with dependent variables such as reading and maths.

The results indicated that SIPT scores might be related to mathematic and reading performance at older ages. Praxis and visual perceptual scores were related to reading, whilst praxis scores were found to be a good predictor of overall academic performance (Parham, 1998). The study controlled the influence of IQ, and therefore the findings can safely be attributed to sensory integration functioning and not to higher cognitive skills. The findings from this study provide valuable links to academic performance, but there were considerable limitations such as the small sample size, which signify that the results cannot be generalised.

2.3.5.4.1 Exploration of cognitive impediments on academic achievement

Executive functioning, a set of cognitive functions, such as attention control and shifting, working memory, self-regulation, reasoning and planning, were predominantly investigated in the child living in poverty (Dickerson and Popli, 2016; Ford and Stein, 2015; Segretin et. al., 2016; Ursache and Noble, 2016). Ursache and Noble (2016) found that the performance on memory tasks, especially working memory, the ability to shift attention and inhibitory control were reduced in children living in poverty. The authors argued that this population is less likely to suppress irrelevant information from the environment as they have inefficient recruitment of neural resources or adaptability in brain structures (Ursache and Noble, 2016). More recently, Segretin et. al. (2016) added factors such as difficulties with impulsiveness and mental planning to these executive difficulties. Another area of executive function affected by poverty is self-regulation. Self-regulation was described as a child's cognitive ability to modulate their own thoughts, emotions and behaviours purposefully (Flouri et. al., 2014). Besides self-regulation playing a role in inhibitory control there is an important association between self-regulation and emotional and behavioural adjustment (Flouri et. al., 2014). Sharkins et. al. (2017) portray the child's ability to regulate as important, as it accounts for 87% of the development of social emotional skills.

Children with sensory integration difficulties were found to have similar difficulties with paying and shifting attention, inhibitory control, impulsiveness, and planning of actions (Case-Smith et. al., 2015). Sensory integration theory, however, explains these difficulties as an underlying physiological process related to the intensity of the arousal level of the child termed as sensory reactivity (Bundy et. al., 2002; Gouze et. al., 2009). Tactile defensiveness, a sensory integration dysfunction indicating over-reactivity to tactile sensory input, was similarly found to play a role in the child's ability to maintain attention (Smith Roley et. al., 2007).

Not only does sensory reactivity result in cognitive difficulties but difficulties in sensory perception may contribute as well. Hitier et. al. (2014) found that different vestibular pathways are involved in cognitive functions as it plays a role in spatial memory, and spatial learning and orientation. These functions in turn have an influence on cognitive functions such as object recognition, numerical cognition and linguistic functions (Hitier et. al., 2014).

Further, the ability to plan actions mentally is described as a sensory perceptual function, which involves tactile discriminative functions influencing praxis skills. Praxis skills are described as the ability to plan, organise and execute motor skills (Ayres, 1972b; 2005; Schaaf and Mailloux, 2015).

2.3.5.4.2 Exploration of language impediments on academic achievement

The influence of sensory integration difficulties on language could be a contributing factor to academic performance. Language is a symbolic process through which children learn to understand and interpret information from their environment (Hurt and Betancourt, 2015). A study by Bowman and Wallace (1990) discovered that children from low socio-economic environments scored notably lower on the Praxis on Verbal command subtest of the SIPT than those from higher socio-economic environments. As this subtest measures somatopraxis, language comprehension and memory, it provides valuable information on the link between language and sensory integration. Sensory perceptual difficulties in the vestibular and somatosensory systems were found to have a contributing role in the development of language skills. Magrun et. al. (1981) linked a depressed post-rotary nystagmus, an indication of vestibular function, as playing a role in speech and language acquisition and articulation. Studies by Ayres and Mailloux (1981), Mauer (1999) and Tew (1984) confirmed these findings on the influence of the vestibular and somatosensory systems in the acquisition and understanding of speech and speech production, e.g. articulation.

Hoff (2006) found consistent evidence that environmental influences, such as growing up in low socio-economic environments, have a negative influence on language development. Studies on the effect of language development in children from low socio-economic areas found that aspects such as poor oral and written language, poor phonological awareness, poor reading ability and poor receptive language are more prevalent (McCoy et. al., 2015b; Piccolo et. al., 2016a; Segretin et. al., 2016; Ursache and Noble, 2016). Hoff (2013) presented oral language as the biggest problem in this population and related it to poor vocabulary and phonological awareness. A study related to vocabulary, conducted by Hart and Risley (1992), found that at the age of four years, children from high socio-economic areas had a vocabulary of 48 million words, whereas those from low socio-economic areas only had 13 million words.

Although the development of vocabulary in children from low socio-economic areas influences the child's oral language, it also influences their ability to process receptive language (Schwab and Lew-Williams, 2016). Ryan et. al. (2016) investigated the relationship between receptive language, the ability to understand what is being said, and expressive language, or the ability to relate thoughts to words, and found children from disadvantaged environments showed significant differences in both.

These findings indicate that children's ability to express themselves is better than their ability to understand words or the meaning of what is being said (Ryan et. al., 2016).

2.3.5.5 Difficulties observed in motor skills

Children with sensory integration difficulties experience difficulties in motor skills, such as reduced balance, bilateral coordination and control, difficulty to imitate postures and movement and copying movements on verbal command (Smith Roley et. al., 2007). Ayres (2004) developed the SIPT to assess for these difficulties, yet only one study was found that used the SIPT for assessment of children within low socio-economic environments. Bowman and Wallace (1990) investigated the effect of socio-economic status on hand measures, vestibular function, visual-motor integration and praxis in a group of children between the ages of 36 and 72 months. Twenty children from low socio-economic areas were matched with a similar group from a high socio-economic area. The study found that children from high socio-economic areas had bigger right hands and better strength in that hand, which could explain their higher scores for fine motor skills. Another finding was that children from low socio-economic environments had lower scores for visual-motor integration and significantly lower scores on praxis on verbal command for both time and accuracy. The authors, Bowman and Wallace (1990), hypothesised that this could be due to differences in the child's developmental level, differences in praxis abilities between the two social groups, differences in language skills or a combination of the above. No differences were found in vestibular functioning between the two socio-economic groups.

Numerous studies, found that children living in low socio-economic environments, have more difficulties in mastering motor skills, compared to those living in high socio-economic environments (Bellows et. al., 2017; Cohen et. al., 2014; Venter et. al., 2015; Valentini et. al., 2015). Different areas of motor development were investigated, and focused on the mastery of fundamental movement skills (Bellows et. al., 2017; Cohen et. al., 2014), coordination, (Bowman and Wallace, 1990; Venetsanou and Kambas, 2010), fine motor skills (Dinehart and Manfra, 2013), gross motor skills (Le Roux, 2013) and perceptual motor skills (Pienaar et. al., 2014).

Bellows et. al. (2017) and Venter et. al. (2015) focused their investigations on the development of the underlying building blocks for motor skills, known as fundamental movement skills, in children from low socio-economic areas. Fundamental movement skills include locomotion, stability and object control. In a South African study by Le Roux (2013), children from high and low socio-economic environments, were assessed for motor skills using the Bruininks-Oseretsky Test of Motor Proficiency (BOT). Results of this study indicated significant differences between the two socio-economic groups. Children in the higher socio-economic group performed better on fine motor precision, fine motor integration, object control, handedness, bilateral coordination, strength and upper limb coordination.

Participants from low socio-economic environments were however better in kicking, with no differences between the two groups in balance, running speed and agility (Le Roux, 2013). Bellows et. al. (2017) conducted a similar study and utilised the Bruininks-Oseretsky Test of Motor Proficiency Second Edition (BOT-2) to determine motor skills in children aged three to five years old. The focus of this study was however on gross motor skills, such as balance, running speed, upper limb coordination and strength. Children from low-income areas scored significantly lower for balance and object control compared to a norm-referenced sample (Bellows et. al., 2017).

Several studies on motor development in children from low socio-economic areas, investigated the possibility of Developmental Coordination Disorder (DCD) in this population. DCD is a neurodevelopmental disorder explained as a problem with learning and executing coordinated movement that includes a range of motor problems such a clumsiness, poor balance, difficulties using objects, such as catching and throwing a ball (Elbasan et. al., 2012). DCD was investigated as the cause of motor difficulties in children from low socio-economic environments. Valentini et. al. (2015) investigated DCD in this population and assessed a large sample, of 1056 children, aged 4 to 10 years in Brazil, using the used the Movement Assessment Battery for Children, Second Edition (MABC-2). Children from low socio-economic environments in Brazil were found to have a higher risk of DCD than children in the US, the UK and Canada (Valentini et. al., 2015). There is some confusion in the literature regarding the terminology as dyspraxia is frequently used as a synonym for DCD and some evidence was found where sensory integration was used as a synonym for DCD (Koenig and Rudney, 2010). As different terminology is used in describing dyspraxia, occupational therapists find the research confusing and difficult to include in evidence-based practice.

2.4 EVIDENCE FOR SENSORY INTEGRATION THEORY

Sensory integration is one of the most researched fields in occupational therapy, yet there seems to be much controversy regarding evidence for the effectiveness of sensory integration intervention, as well as an ongoing debate on the use of terminology (Schaaf et. al., 2010b; Smith Roley et. al., 2007). It is important to address the issues of clinical evidence for the effectiveness of sensory integration intervention and terminology in sensory integration to maintain the integrity of Ayres Sensory Integration.

2.4.1 Clarification of sensory integration terminology

Confusing and inconsistent terminology causes controversy in sensory integration research. The use of sensory integration by one group of occupational therapists and the use of sensory processing by another group frequently confuses occupational therapists, parents and other healthcare professionals. The difference in terms came about as a group of occupational therapists, led by Lucy J. Miller and Shelly Lane, proposed the use of sensory processing rather than sensory integration to distinguish the disorder from the theory and intervention (Lane et. al., 2000). To preserve and clarify Ayres original work, another group led by the Bakers and Ayres trust decided to trademark the term Ayres Sensory Integration® (ASI®) (Smith Roley et. al., 2007) and by doing so, ensure the original and correct use of terminology and theory as proposed by Dr Jean Ayres. Scholars of ASI® therefore continue to use the term sensory integration to describe the theory, assessment and intervention of sensory integration difficulties as described by Jean Ayres.

Not only is there confusion regarding the term sensory integration within the occupational therapy community, but it is frequently used to describe sensory based interventions such as sensory stimulation used by teachers. Schaaf and Mailloux (2015) clarify this concept by explaining that ASI® is a child-directed approach that requires active participation with the environment resulting in an adaptive response. In comparison, some sensory based interventions include the passive provision of stimulation to a person (Smith Roley et. al., 2007).

Recently, changes to terminology were introduced by Schaaf and Mailloux (2015), who talk about sensory perception compared to sensory discrimination to explain the difficulty in identifying and discriminating sensation in sensory systems. Difficulties in the way a child reacts to the intensity of the sensory input were previously described as sensory modulation, but now termed sensory reactivity, reactivity indicating either hyper-reactivity or hypo-reactivity (Schaaf and Mailloux, 2015). The change in terminology was made to be consistent with the terminology used in the new Statistical Manual of Mental Disorders (American Psychiatric Association, 2013).

2.4.2 Clarification of sensory integration assessment and intervention

The ASI® group of scholars continue to build on the work of Ayres through continued research to confirm the patterns of sensory integration dysfunctions, as well as to ensure that intervention adheres to the ASI® Fidelity Measure (Mailloux and Miller-Kuhaneck, 2014; Mailloux et. al., 2011; Parham et. al., 2011). Ayres (1989), Mulligan (1998) and Mailloux et. al. (2011) identified specific sensory integration patterns of dysfunction following rigorous statistical analysis (factor analysis) based on SIPT results. Five distinct patterns were identified as somatodyspraxia, vestibular and proprioceptive-based bilateral integration and sequencing, visuodyspraxia, tactile and visual discrimination, and tactile defensiveness and attention (Mailloux et. al., 2011). These patterns of dysfunction are still currently used to distinguish between the different sensory integration dysfunctions.

The same group proposing the change of terminology to sensory processing proposed changes to the diagnosis of patterns of dysfunction, to include those children who were unable to complete a SIPT (Miller et. al., 2007). These patterns are based on sensory integration difficulties as identified in general sensory integration research. The taxonomy for diagnosis by this group included three areas, namely a dysfunction in praxis (dyspraxia), SMD and dysfunction in discrimination (Lane et. al., 2000).

Despite the differences in terms and proposed diagnostic classification, the two groups believe that the processing and integration of sensory happen in the brain and are dependent on an actual neurological process, as proposed by Ayres. To prevent confusion regarding the provision of sensory integration intervention and to ensure that research studies are replicable, a fidelity measure was developed for intervention (Parham et. al., 2011). The ASI® Fidelity Measure provides specific elements based on the core concepts of sensory integration to guide intervention (Schaaf et. al., 2015). Schaaf and Mailloux (2015) further attempted to limit confusion regarding assessment and intervention through the establishment of the Data Driven Decision Making (DDDM) model. The data driven decision making process aims to guide a therapist through a step-by-step approach to the gathering of data, analyses of data and implementation of intervention and the measuring of outcomes in a manner which are replicable (Schaaf and Mailloux, 2015). Collecting information on the child's context and conducting a thorough assessment provides valuable information on the child's difficulty in processing sensory information. The use of standardised assessments to gather information on sensory integration is the preferred method of assessment (Schaaf and Mailloux, 2015).

2.5 ASSESSMENT OF SENSORY INTEGRATION DIFFICULTIES AND PATTERNS OF DYSFUNCTION

Sensory integration is the foundation for the development of skills in children following a sequence where one skill builds upon another skill (Ayres, 2005). Difficulty with sensory integration may result in weak foundational skills and poor occupational performance. Early detection of developmental difficulties due to poor sensory integration is of importance in preventing learning difficulties, especially once the child commences with formal schooling.

A limited number of sensory integration standardised assessments are available to determine the various components of sensory integration. Jorquera-Cabrera et. al. (2017) identified the SIPT, Sensory Profile (SP) and the Sensory Processing Measure (SPM) as the most frequently used assessments for sensory integration. Mailloux et. al. (2018) described the SIPT as the only test that includes the core concepts of sensory integration. Ayres (1989) developed the SIPT to discriminate between typically developing children and those with suspected sensory integration difficulties with normal intelligence. The test consists of 17 subtests that measure specific practical abilities as well as tactile, proprioceptive, vestibular and visual processing, but does not include measures for taste, olfactory and auditory processing (Bodison and Mailloux, 2006). The SIPT was not developed to measure or predict actual functioning, such as reading and writing, but to provide information on the underlying constructs that will play a role in occupational performance tasks (Ayres, 1989).

Although the test was developed and normed on a large sample within the US, including children from various geographic areas, sex, age and cultural backgrounds, validity and reliability studies were done on much smaller populations (Ayres, 1989). Bundy et. al. (2002) and Schaaf and Smith Roley (2006) describe the SIPT as the gold standard for assessment of sensory integration as it is comprehensive and statistically sound. In 2012, Van Jaarsveld et. al. (2012) published a study on the use of the SIPT on a South African population of 775 children, between the ages of 4 years 0 months and 8 years 11 months. The results showed the South African sample performed moderately to significantly better on the Design Copying test, the Bilateral Motor Coordination test, Oral Praxis test, Standing and Walking Balance and Motor Accuracy tests in the older age bands of 6 years 0 months to 8 years 11 months (Van Jaarsveld et. al., 2012). According to these findings, 12 of the 17 tests can be used without adapting the score, but for the five mentioned tests, it was recommended that the scores be adapted with -0.5 of a standard deviation to ensure fair interpretation. This study provided valuable information on the usefulness of the SIPT in South Africa. The researcher alluded to the fact that although the sample did not include a representative sample of children from low to very low socio-economic environments, the sample did represent the population of children in South Africa that have access to sensory integration assessment and intervention (Van Jaarsveld et. al., 2012).

This finding highlighted the fact that the SIPT is not frequently used within low socio-economic environments to identify sensory integration difficulties. There may be some challenges to using the SIPT in low socio-economic environments, such as the cost involved in the administration. Due to the exchange rate between the South African Rand and the US Dollar, it is extremely expensive, and most public health facilities are unable to procure the test. As almost all children from low socio-economic environments are seen in public healthcare facilities, the availability of the SIPT is limited. Another challenge is that instructions are very specific and only available in English and Afrikaans. In South Africa there are 11 official languages and not all children speak English (Statistics South Africa, 2017). This means a translator is needed as some of the terminology is not familiar in all the languages, e.g. on the praxis on verbal command test some black languages do not have specific words for 'together' or 'bottom of your foot,' and in the constructional praxis test there are children who do not know the meaning of the word 'chimney.'

The fact the SIPT needs to be administered by an occupational therapist trained in sensory integration is problematic in low socio-economic areas where services are provided by community service occupational therapists who are young and have minimal experience (less than a year), having only recently completed their training. Ayres (2005) acknowledged that sensory integration dysfunctions can be difficult to identify and frequently overlooked, especially by an occupational therapist not trained in sensory integration.

The SIPT measures only sensory perception or the discriminative components of sensory integration. Other assessments, such as the SP or the SPM, are needed to assess the sensory reactivity or modulation components of sensory integration (Dunn, 2014; 1999; Parham et. al., 2007). Both the SP and SPM are questionnaires completed by either the parent/caregiver or teacher to determine sensory integration difficulties concerning behaviours and function. Both instruments include a questionnaire on sensory reactivity for parents, a questionnaire for school environments and other social environments, with the inclusion of questions regarding praxis in the SPM (Dunn, 2014; 1999; Parham et. al., 2007). Although these questionnaires are easy to complete and less expensive than the SIPT, the language aspect is still problematic for use in the South African context and remains the perception of the adult on the child's sensory experiences. Questions are set in a way to measure a construct, which makes it difficult to translate the questionnaire during use. Some items are formulated from a more westernised context, for e.g. the SP asks whether the child dislikes going barefoot, but children from low socio-economic environments frequently walk barefoot as they do not have shoes.

These contextual differences do raise questions regarding the reliability of the results. Many parents from low socio-economic environments are illiterate and unable to read and thus the use of questionnaire is not always appropriate. Analysis of the current instruments, namely the SIPT, SP and SPM, indicated that although they are instrumental in assessing sensory integration constructs, they are currently not optimal for use in the South African context.

Recently the ASI® community acknowledged these above-mentioned challenges as well as the fact that norms may have changed due to changes in human activity patterns in the new technological age (Mailloux et. al., 2018). This realisation led to the development of a new measurement the Evaluation in Ayres Sensory Integration® (EASI®) (Mailloux et. al., 2018). The developers propose that this measurement will be more relevant for international populations, inexpensive and easier to access via online resources. The EASI® will allow for assessment of children 3 to 12 years of age, compared to the 4 years to 8 years 11 months of the SIPT (Mailloux et. al., 2018). Although the development of the EASI® is still in the pilot testing phase, preliminary findings show that four patterns of sensory integration will be assessed namely, (1) sensory perception, (2) praxis, (3) ocular, postural and bilateral motor integration and (4) sensory reactivity (Mailloux et. al., 2018). The prospect of a valid and reliable international sensory integration test is promising, yet it will still only be available for use by occupational therapists trained in sensory integration.

Community service occupational therapists in South Africa will still not be able to use the EASI® as they have limited knowledge of sensory integration. To fill this gap, a sensory integration screening instrument with short instructions in different local languages, affordable equipment and that consists of observations of sensory integration behaviours is needed. Such a screening instrument will assist community service occupational therapists to use observations to determine if children living in a low socio-economic environment are at risk of having sensory integration difficulties. Further investigation into the influence of living in low socio-economic areas on a child's ability to integrate sensory information and react adaptively to the environment is required.

2.5.1 Appraisal of sensory integration assessments for the South African context

Switzer et. al. (1999) advised that a new instrument should only be developed if there were no other instruments available for use and that existing instruments should first be analysed for appropriateness for use in a specific setting. Fawcett (2013) agreed with this view as the adaption of an existing instrument could lead to changes in the rationale of the instrument, as well as the reliability and validity.

The use of standardised instruments is encouraged to ensure consistent administration and scoring of the instruments to guarantee reliability and validity. As part of the conceptualisation process, four assessment instruments for sensory integration were critically appraised for use in low socio-economic environments in South Africa. The criteria for the critical appraisal were based on a content analysis of the literature on the development of culturally appropriate instruments (see Table 4.3 for the criteria used). The four sensory integration instruments included the SIPT, the SPM, the SP and the TSI test as they were developed for detecting difficulties in the processing and integration of sensory input. Jorquera-Cabrera et. al. (2017) identified the SIPT, SP and SPM as the most frequently used assessments for sensory integration. Table 2.1 presents the critical appraisal of these frequently used assessments.

Table 2.1: Critical appraisal of sensory integration assessment instruments according to set criteria

	PURPOSE Appropriate for SI	POPULATION Appropriate Age & Gender	POPULATION Appropriate for use for low SES SA population	CULTURAL CONTEXT Items appropriate SA /low SES context	CULTURAL CONTEXT Instructions applicable SA	SCORING Easy & Quick	ADMINISTRATION Appropriate length of test/Burden on therapist	ADMINISTRATION Cost effective	ADMINISTRATION Minimum Equipment	ADMINISTRATION Specialist training needed	Appropriate SA Internal consistency reliability	Appropriate SA Test-retest reliability	Appropriate SA Content validity	Appropriate SA Criterion validity	Appropriate SA Construct validity
SENSORY INTEGRATION AND PRAXIS TESTS (SIPT) (Ayres, 2004)	**X** **Diagnostic Assessment** Assessment of severe difficulties with sensory processing and practic abilities	√ 4 years 0 months – 8 years 11 months	√ Data available but based on middle class and higher SES	X Some items e.g. PrVC not appropriate low SES context	X Instructions very specific Not available in African languages	X Long & Tedious 4-point scale Scoring different for each subtest z-scores	X Administration and scoring time Consuming	X Due to exchange rate, very expensive for SA therapists	X Specific equipment kit required	X Needs specific post-graduate training	X	X	X	X	X
SENSORY PROCESSING MEASURE (Parham et. al., 2007)	**X** **Rating scales** Assessment of sensory processing, praxis & social participation	√ 5 years – 12 years	X Minimal data available from local studies	X Some items not appropriate low SES context	X Questions not in African languages.	X Easy 5-point Likert scale Category	√ 15 – 20 min	√ Question-naires not as expensive	√ Require only question-naire sheets	√ Basic under-graduate knowledge on testing procedures	X	X	X	X	X
SENSORY PROFILE™ 2 (Dunn, 2014)	**X** **Rating scale.** influence of sensory processing difficulties on home, school and community	√ birth – 14 years	X Minimal data available from local studies	X Some items not appropriate low SES context	X Questions not in African languages.	X Easy 5-point Likert scale	√ 5 – 20 min	√ Question-naires not as expensive	√ Require only question-naire sheets	√ Basic under-graduate knowledge on testing procedures	X	X	X	X	X
DEGANGI-BERK TEST OF SENSORY INTEGRATION (TSI) (Berk and DeGangi, 1983)	**X** **Diagnostic Assessment** Criterion-referenced assessment delays in sensory, motor, and perceptual skills	X 3-5 years	X Minimal data available from local studies	√ Movement activities applicable to all children	X Specific verbal instructions Not in African languages.	X Easy Each subscale different criteria	√ 30 min	X Due to exchange rate, very expensive for SA therapists	X Specific equipment kit required	√ Basic under-graduate knowledge on testing procedures	X	X	X	X	X

The results of the critical appraisal of these four instruments indicated that none of the instruments fit all the criteria for use within the set research population. Fifteen criteria were considered for the South African context. These criteria were marked correct when applicable or incorrect if not applicable. To determine the percentage of criteria that were adhered to, the correct number of criteria were divided by 15 and multiplied by 100. The SIPT, the gold standard in the measurement of sensory integration difficulties, adhered to only 13% of the criteria. The other diagnostic instrument, the TSI met 20% of the criteria and the two rating scales adhered to 33% of the criteria. The rating scales focus mostly on the sensory modulation aspect of sensory integration, instead of sensory modulation and sensory discrimination (Dunn, 2014; Parham et. al., 2007). All the appraised instruments have good validity and reliability in assessing sensory integration difficulties however, no psychometric data were available for the low-socio economic population from South Africa (Ayres, 2004; Parham et. al., 2007; Dunn, 2014; Berk and DeGangi, 1983).

The population criteria for this study required a test suitable for children between the ages of 5 years to 6 years 11 months and applicable for use in the South African context. The SIPT, SP and SPM can be used for children of the specified age, but the TSI is only for children aged 3 to 5 years. The SIPT is the only assessment with data available on the use of the test for children in South Africa. A study by Van Jaarsveld et. al. (2012) showed that South African children tested similar, or better, on five of the tests than the US sample, as mentioned earlier. The limitation of the study was it was mainly done on children from high to middle socio-economic environments. The TSI was used by Van Jaarsveld et. al. (2001a) to determine the prevalence of sensory integration difficulties in children 3 to 5 years of age in a low socio-economic area in Bloemfontein, South Africa. This study showed sensory integration difficulties in the sample population but did not provide information on the suitability of the instrument for determining sensory integration difficulties.

Appropriateness for the cultural context investigated the appropriateness of items for local cultures and the difficulty and specificity of instructions. All four instruments have items that are unfamiliar to the South African population. The instructions for the instruments are all in English and specific instructions, especially wording, are required for it to be administered in a valid and reliable way. The SIPT has specific verbal instructions that may not be altered to make instructions clear or understandable. The Praxis on Verbal Command Test, which measures a child's ability to plan movements based on verbal instructions, was found to be difficult to administer to non-English speaking children (Bodison and Mailloux, 2006). The SP and SPM are questionnaires that ask specific questions regarding the child's reactivity to sensory input. In South Africa, many parents are illiterate and unable to read the questionnaires. A translator can be used to ask the questions but there is the possibility the question's meaning gets lost in translation. Some items also ask questions on activities that are unknown in the local cultures.

Characteristics investigated under administration included the length of the assessment, the cost involved, specific equipment needed and if specialist training would be required. In the low socio-economic areas of South Africa, recently qualified therapists working in government services and with limited sensory integration knowledge provide occupational therapy services. The government hospitals and clinics where children are seen do not have the finances to acquire expensive assessment instruments and specific equipment, and due to high caseloads, children are only observed for short periods of time and infrequently.

The SIPT and TSI require specific equipment and scoring materials that need to be imported from the US. The SP and SPM are not as expensive and easily available from local suppliers who import the instruments. Three of the instruments are comprehensive enough to administer in a short time, but the SIPT can take up to three hours for administration and another hour for scoring, which increases the burden on the occupational therapist with a high caseload. Specialist postgraduate training is needed to administer the SIPT, and therefore young unexperienced occupational therapists are unable to use this instrument in a public health or community setting.

All four instruments were found to be valid and reliable for use in Western countries, yet no data were available for the validity and reliability within a low socio-economic environment in South Africa. The need for a sensory integration-screening instrument that considers the specified population and cultural context was identified.

2.6 SENSORY INTEGRATION IN THE SOUTH AFRICAN CONTEXT

Schaaf et. al. (2018) proposed that a reported 5% to 16% of children in the US have trouble in processing and integrating sensory information. In South Africa, the prevalence of sensory integration difficulties has not been fully established. A study by Van Jaarsveld et. al. (2012) found that South African children tested similarly to the US sample on the SIPT, and in the older age groups of 6 years to 8 years 11 months even better on some tests. In terms of prevalence, this possibly means that one can expect a similar prevalence to that of the US. As South Africa is a developing country with more than 63% of children living in poverty, the prevalence of sensory integration difficulties may be higher than expected due to the impact of the environment (Jamieson et. al., 2017; Statistics South Africa, 2017).

Very little research is however available on the prevalence of sensory integration difficulties in children, from low socio-economic environments in South Africa. A descriptive study on children aged 3 to 5 years from low socio-economic environments in Mangaung, Bloemfontein, found a significant prevalence of children with sensory integration difficulties (Van Jaarsveld et. al., 2001a).

This study further found that 40.4% of the children from the low socio-economic school tested at a higher risk for bilateral integration difficulties than children from a higher socio-economic class (Van Jaarsveld et. al., 2001a). Lecuona et. al. (2016) investigated the prevalence of sensory integration difficulties in premature infants, from low socio-economic environments, in a tertiary hospital in Bloemfontein, South Africa. The authors investigate infants' ability to process and integrate sensory information from the environment. The findings of this study indicated that 70.8% of the infants experienced difficulties with sensory reactivity, by either displaying under-reactivity or low thresholds to sensory information resulting in over-reactive behaviours (Lecuona et. al., 2016). The study further found that 79.2% of the sample had difficulties with adaptive motor function and ocular-motor control, indicating poor sensory integration (Lecuona et. al., 2016). Four similar studies were done, by students from the University of the Free State in Bloemfontein, South Africa, to investigate sensory integration in children from different socio-economic environments. All four studies compared results on children growing up in low socio-economic environments versus those growing up in high socio-economic environments (Van Jaarsveld, 2010). Comparative results indicated statistical significant differences were present in the data of children from low and high socio-economic environments, with children from high socio-economic environments, performing better on total test scored for bilateral motor coordination (Van Jaarsveld, 2010). Total test score results for postural control showed an overall tendency for children from high socio-economic environments to perform better than their counterparts from low socio-economic environments. An overall conclusion was reached that children from low socio-economic environments are more prone to have trouble with components dependent on sufficient sensory integration. Although these studies were small and executed in the same city, namely Bloemfontein, preliminary results are indicative of a prevalence of sensory integration difficulties in children from low socio-economic environments.

The researcher is however, of the opinion that despite having provisional proof of sensory integration difficulties in children from low socio-economic environments, these problems are frequently missed in the assessment of children. A retrospective document review, was done as part of a pilot study of children at an outpatient clinic at a provincial public healthcare hospital in the North-West Province, South Africa (Van der Linde and Olivier, 2010). The record review was done to determine the frequency of referral for assessment in the community, as well as to determine if any sensory integration difficulties were not accounted for in the assessment (Van der Linde and Olivier, 2010). The reasons for referral were similar to those seen in children with sensory integration difficulties, e.g., weaker performance in school, slow learner, and difficulty in paying attention, poor social skills, and poor gross and fine-motor skills. The review found the children were experiencing difficulties with the processing of sensory information and that these difficulties were missed by the occupational therapists working in the community.

Occupational therapy services within the community are largely provided by newly qualified community service therapists (Van Jaarsveld, 2010). They have basic knowledge of sensory integration difficulties, as the use of sensory integration assessment and treatment requires post graduate training and knowledge and can only be provided by a therapist who has completed this specialised post graduate course (Van der Linde, 2009). Community service occupational therapists do not have access to appropriate, cost effective assessment tools to identify sensory integration difficulties as previously discussed. Access to an occupational therapist with specialised knowledge in sensory integration is therefore limited for children from low socio economic environments as 40% of these qualified sensory integration therapists are working in private practice (Van der Linde, 2009). The development of an appropriate screening instrument for use within low socio-economic environments would be ideal to assist community occupational therapists to identify children at risk of having sensory integration difficulties.

2.7 CONCLUSION

The literature review on sensory integration and the developmental risk factors of growing up in low socio-economic environments emphasised the influence of the environment on the processing and integration of sensory input on occupational performance. The ability to process and integrate sensory information from the environment is described as the foundation for learning and behaviour (Ayres, 1972a). Ayres (1972a) believed that participation in activities provided the child with feedback from their bodies and the environment, resulting in adaptive responses and building neuronal models. Good sensory integration results in engagement in occupations that include adequate cognitive, motor, emotional and social development.

As the processing and integration of sensory input is dependent on the environment, risk factors within the environment may affect the child's ability to engage in activities (Ayres, 1972a). Risk factors such as poor nutrition, poor nurturing parental care, non-stimulating environments, extreme stress and threatening or unsafe environments play a role in the child's sensory development and drive to engage in the environment. Children with sensory integration difficulties and from low socio-economic environments had similar developmental difficulties, such as poor motor skills, poor cognitive and language skills, poor social skills and emotional difficulties. Limited research was found on whether these difficulties were either due to sensory integration difficulties, the influence of a low socio-economic environment or a combination of these.

Provisional investigations by Lecuona et. al. (2016), Van Jaarsveld et. al. (2001a), Van Jaarsveld (2010) and Van der Linde and Olivier (2010) found high incidences of sensory integration difficulties in children from low socio-economic environments. There are a number of challenges to assess sensory integration difficulties in children from low socio-economic environments, as the SIPT, SP and SPM are less optimal for this population in South Africa. Identification of sensory integration difficulties in the South Africa context is further challenged by the fact that services within low socio-economic environments are mainly provided by community service occupational therapists with a basic or minimum knowledge of sensory integration.

This literature review emphasised the vital influence of the environment in the processing and integration of sensory input and that children from low socio-economic environments are in jeopardy of developing sensory integration difficulties (Van Jaarsveld et. al., 2001a; Van Jaarsveld, 2010; Van der Linde and Olivier, 2010). It is therefore important to ensure that these children are assessed for sensory integration difficulties. To empower community occupational therapists to assess for possible undetected sensory integration difficulties the development of an appropriate, cultural, low cost screening instrument is essential.

CHAPTER 3: THE LITERATURE REVIEW ON TEST DEVELOPMENT

3.1 INTRODUCTION

Chapter 2 reviewed the literature on sensory integration and the development of children growing up in low socio-economic environments. This review established the need for the development of a cost effective, culturally appropriate screening instrument for determining if children from low socio-economic environments are at risk of having sensory integration difficulties. Chapter 3 will review the literature on assessing children from low socio-economic environments and the process that needs to be followed to develop a screening instrument to determine the risk of sensory integration difficulties in children from low socio-economic environments.

3.2 INTRODUCTION TO TEST DEVELOPMENT

Occupational therapists use standardised tests to assess the strengths and difficulties of children to plan and guide intervention and service delivery. These standardised tests provide specific norms for the level of the child's performance and are thus categorised as norm-referenced tests. Assessment within the sensory integration frame of reference determines the sensory integration factors to be addressed in intervention (Schaaf et. al., 2014). Various standardised assessments, such as the SIPT, the SP and the SPM, are available to determine some of the discriminatory and modulatory factors of sensory integration difficulties (Ayres, 2004; Dunn, 1999; Parham et. al., 2007). The SIPT is seen as the gold standard for the measurement of sensory integration and is one of the most researched assessment instruments for determining sensory integration difficulties (Schaaf and Smith Roley, 2006; Bundy et. al., 2002). The SIPT, as well as the SP and SPM, are frequently used in South Africa yet only the SIPT has adapted scoring criteria for the South African population aged 6 years 0 moths to 8 years 11 months (Van Jaarsveld et. al., 2012). Van Jaarsveld et. al. (2012) used a convenience sample of 775 children to determine the validity and reliability of the SIPT for South African children. The findings of this study confirmed that the US norms could be used for 12 of the 17 tests in South African children, but that South African children performed better on five of the tests. The authors recommended that these five tests (Design Copying, Bilateral Motor Coordination, Oral Praxis, Standing and Walking Balance and Motor Accuracy) be adjusted by -0.5 SD to the negative side in age bands over 6 years 0 months to ensure difficulties are identified (Van Jaarsveld et. al., 2012). One limitation of the study was that the sample was not normally distributed in terms of the ethnicity and socio-economic status of children in South Africa.

Delany et. al. (2016) reported that in 2014 the child population in South Africa was distributed as follows: Black (84%), Coloured (8%), White (5%) and Indian (2%). The study by Van Jaarsveld et. al. (2012) included 81% White children, 3.6% Black children, 6.7% Coloured children and 4.5% of children who did not have their racial group indicated. This means the adapted scoring criteria is not necessarily applicable to all children in South Africa. No normative data are available for the South African population for the SP and SPM.

3.3 EVALUATION OF STANDARDIZED ASSESSMENT INSTRUMENTS FOR USE IN THE SOUTH AFRICAN CONTEXT

South Africa is a country with a multitude of different languages, cultures, severe discrepancies between poor and rich, and people living in urban and rural settings (Statistics South Africa, 2017). The population and context are therefore diverse and require appropriate assessment instruments to measure deficits in children from all settings. Occupational therapists, therefore, need to review the properties of a test critically before selecting an instrument for use. Issues such as the type of instrument, the norm-referenced population, the clinical utility, method and type of scoring, and the psychometric properties should be investigated.

To determine if a standardised assessment instrument is applicable for use in a specific context, the occupational therapist firstly needs to investigate the purpose of the assessment, e.g. if a screening instrument or an in-depth assessment is needed. Smolkowski and Cummings (2015) explained that the goal of an assessment determines the use of a diagnostic or screening instrument. Their findings indicated the diagnostic instrument is used for a specific sample to guide decision making concerning specific members of a population. A diagnostic instrument is used to investigate a specific area of function in children compared to norms and standards and usually requires specific training (Foxcroft and Roodt, 2013); a screening instrument is used to assess an entire population to predict the risk of a condition (Smolkowski and Cummings, 2015; Richardson, 2014). Screening instruments are traditionally short, cost effective and provide a comprehensive view of a child’s functioning rather than an in-depth assessment of a specific area (Bédard and Dickerson, 2014). Macy (2012) agreed that a screening measure provides only a snapshot of the child’s development at that specific place in time. The screening information can guide decisions to address the child’s needs and if further assessment is indicated or not.

A study by Kramer et. al. (2009) investigated the strategies occupational therapists use to choose an assessment instrument. Information from focus groups indicated that the participants choose an instrument depending on what they want to know about the child, their difficulties, and the feasibility of use, administration procedures and length of the test.

Richardson (2014) agreed that it is essential to choose a test that will assess the child's weaknesses and strengths and that is intended for the specific population for which it is used. Another highlighted aspect was the fact that instruments are chosen according to the policies and the nature of the service delivery in the area or context where the therapist works (Kramer et. al., 2009). In some instances, legislation, reimbursement and the size of the population requiring the service, forces therapists to take into account the cost of an assessment instrument, the time it takes to administer and score the instrument, as well as the specific training requirements to be able to administer the instrument (Kramer et. al., 2009). The OTPF III also emphasised the importance of ensuring the standardised assessment instruments are valid and reliable for the population they will be used for and that reliable norms are available to determine difficulties (AOTA, 2014).

Switzer et. al. (1999) described instruments in four categories, established measures, modified measures, hybrid measures and new measures, and discussed specific aspects that need to be considered when choosing to use or change an instrument. The first aspect requiring investigation includes the type and purpose of the assessment instrument. Types of assessment instruments vary depending on whether they are psychological, educational or healthcare instruments. Guidelines by the American Educational Research Association et. al. (2014) described five types of instruments, i.e., diagnostic assessments, neuropsychological evaluations, intervention planning and outcome, judicial and governmental decisions and instruments for personal awareness and growth. Streiner et. al. (2014) wrote that although health measures take into account similar types of assessment, the focus was more on the assessing quality of life than on determining achievement for example in school performance. Thorley and Lim (2011) proposed that occupational therapists working with diverse cultures should determine if they want to use assessments for goal setting, to determine eligibility for services or to use the data as part of an outcome measure.

Switzer et. al. (1999) and Glover and Albers (2007) further emphasised the importance of the feasibility of a measurement instrument considering the participant's age, gender and culture, as well as the psychometrics of the instrument. Age and gender are important considerations when choosing an assessment, as these factors play a role in determining the norms of the assessment. In the SIPT, statistical analyses were done to investigate the developmental trends within the age range as well as gender (Ayres, 2004). The Manual Form Perception test indicated that the pace of development decreases as the child gets older, whereas the Localisation of Tactile Stimuli test showed only limited increase in development across ages. The analyses further found there were limited differences between boys in girls in the Constructional Praxis test.

Thirdly, the feasibility of an instrument needs to consider the cultural needs and language of the population. In the South African context, standardised tests used by occupational therapists or psychologists are mainly developed in the US or UK and therefore focus on westernised items and concepts that are not necessarily applicable (Foxcroft, 2011; Venter, 2000). The influence of culture in assessment instruments is well documented. In multicultural assessments, it is important to ensure that construct bias is kept to a minimum. Van de Vijver and Rothmann (2004: 3) define bias as *"If scores are biased, their psychological meaning is not invariant across cultures, and differences between cultural groups in assessment outcome are influenced by cultural or measurement artefacts*."

Cultural aspects, such as language, measuring a construct that is known to the culture, the administration and method of execution, norms for the specific culture, need to be considered (Van de Vijver and Rothmann, 2004; Venter, 2000; Foxcroft, 2011). Van de Vijver and Rothmann (2004) investigated the cultural appropriateness of psychological tests from a labour point of view. They found the Employment Equity Act 55 of 1998 required evidence that psychologists guaranteed assessments were fair and unbiased for all cultures (Labour, 1998). Occupational therapy tests and assessments have not yet been subjected to such investigations.

Language plays a vital role in the administration of standardised assessments. Del Rosario Basterra et. al. (2011) found that examinees are dependent on language for understanding instructions, whereas examiners use language to gain information. In South Africa, using a specific language for assessment instruments can be daunting as South Africa has 11 official languages (Statistics South Africa, 2012b). Ethically, every person has the right to be assessed in the language of their choice (Foxcroft, 2011; Van de Vijver and Rothmann, 2004). The instructions of standardised assessments developed in the US and UK are mainly in English, and by administering the instrument as such, it will bias the results and indicate instead the examinee's ability to understand English rather than their actual ability to perform within the construct of the assessment (Venter, 2000). De Kock et. al. (2013) and Foxcroft (2011) argued that translating instructions may not always be feasible as some words do not always exist in some languages, or specific phrases may be unfamiliar. Translating instructions or tests requires a standardised method of forward and backward translation and often these guidelines are not adhered to (Muniz et. al., 2013). They further indicated that aspects such as using the negative form or idiomatic expressions were found to be problematic. The issue of language is further complicated in South Africa by the fact that the majority of children are educated in English and not in their mother tongue (De Kock et. al., 2013).

Using translators poses a problem, as they need to be sufficiently trained to translate exactly what is said and not add their own interpretation of the words. The International Test Commission Guidelines for Translating and Adapting Tests set out precise guidelines for translating a test or adapting the instructions to another language (Muniz et. al., 2013).

The administration and scoring process of an assessment instrument is another issue that needs to be taken into consideration with multicultural assessments. Not only is administration dependent on language for the instructions, but also determines the type of procedures that will be used, e.g., interview, questionnaires, behavioural observations, computer-based tests or performance assessment (Foxcroft, 2011; Van de Vijver and Rothmann, 2004). The type of test procedure is, however, dependent on the construct that is being measured.

Venter (2000) argued that the use of norms for determining performance is extremely difficult. He reasoned that due to the culturally diverse population, it would be impossible to develop national norms as they would differ between cultures and social groups (Venter, 2000). Herbst and Huysamen (2000) agreed that the use of norms in comparing children from low socio-economic environments with those of more advantaged communities could skew the interpretation of the results. The authors argued that in using norms in children from disadvantaged environments, the results could be wrongly interpreted, e.g. the norms could be suggestive of severe difficulties, such as intellectual disabilities, where in fact it was lack of stimulation. Norms of standardised tests, therefore, need to be interpreted with care and sensitivity.

Herbst and Huysamen (2000) developed a battery of scales, named the Early Childhood Developmental Criteria (ECDC), to assess the cognitive and motor developmental performance of pre-school children, aged three to six years, from low socio-economic environments. The authors found that existing instruments did not meet the criteria for culturally appropriate assessments as described in the above discussion. The battery of scales included the completion of an incomplete man picture, drawing pictures matching the test of Visual Motor Integration, the building of blocks, drawing of stick figures, two and three-dimensional perception of direction, naming and matching of colours, numerical and counting concepts, picture puzzles and picture perception (Herbst and Huysamen, 2000). The instrument measures developmental delay, irrespective of race, and is used in other countries such as Egypt and China (Herbst and Huysamen, 2000). Some of the items and observations of this instrument may provide information on sensory integration, although it was mainly developed to detect developmental delay. It is not however useful for detecting sensory integration difficulties/dysfunctions and the development of a specific sensory integration screening instrument is recommended.

3.4 DEVELOPMENT OF A NEW INSTRUMENT

Switzer et. al. (1999) suggested that if current appropriate instruments are not feasible for use, a new measure could be justified. He does, however point out that there are disadvantages to this approach, such as intensive psychometric analysis and the possibility that the new instrument might not be valid or reliable. Various authors from the fields of psychology, social science, education and health sciences agree that the development of a new assessment instrument can be daunting (DeVellis, 2016; Shultz et. al., 2013; Streiner et. al., 2014)

The Standards for Educational and Psychological Testing provides guidelines on the development of tests to ensure the final product is valid and reliable for the intended use (American Educational Research Association et. al., 2014). The Health Professionals Council of South Africa provide guidelines to psychologists on the use of standardised instruments, but no such document is available for occupational therapists (Health Professions Council of South Africa, 2017); these guidelines are quite generic and would be appropriate for occupational therapists. Despite these guidelines, an exact test design plan is not available, and the actual steps differ depending on the point of view, e.g. a psychological, educational, healthcare or occupational therapy point of view. Test development guidelines, as described by four authors (from different disciplines), are compiled in Table 3.1 and compare the differences as well as the similarities within the process.

Table 3.1: Comparison of test development processes

	(Crocker and Algina, 1986)	(Kielhofner, 2006a)	(Foxcroft and Roodt, 2013)	(DeVellis, 2016)
Discipline		Occupational therapy.	Psychological & Education in South Africa.	Health Sciences.
Step 1	Identify the purpose of the test.	Need for instrument.	Planning: ❖ Specify the aim of the measure. ❖ Define the content of the measure. ❖ Develop the test plan.	Determine what needs to be measured.
Step 2	Identify and define behaviours that represent the construct.	Potential population.	Item writing: ❖ Write the items. ❖ Review the items.	Generate an item pool.
Step 3	Prepare a set of test specifications for items that focus on the construct.	Specific underlying construct.	Assembling and pretesting the experimental version of the measure: ❖ Arrange the items. ❖ Finalise length. ❖ Answer protocols. ❖ Develop administration instructions. ❖ Pre-test the experimental version of the measure.	Determine the format for measure.
Step 4	Contract and initial pool of items.	Operationalise construct.	Item analysis: ❖ Determine item difficulty values. ❖ Determine item discrimination values. ❖ Investigate item bias. ❖ Identify items for final pool.	Experts review initial item pool.

Table 3.1: Comparison of test development processes - continued

Step 5	Have items revised.	Format of instrument.	Revising and standardising the final version of the measure: ❖ Revise test and item content. ❖ Select the items for the standardisation version. ❖ Revise and standardise administration and scoring procedures. ❖ Compile the final version. ❖ Administer the final version to a representative sample of the target population.	Consider inclusion of items.
Step 6	Preliminary item try-outs.	Develop Items.	Technical evaluation and establishing norms: ❖ Establish validity and reliability. ❖ Devise norm tables, setting performance. ❖ Standards or cut-points.	Administer item to developmental sample.
Step 7	Field test items on a large sample representative of population for who test is intended.	Develop supporting material.	Publishing and ongoing refinement: ❖ Compile the test manual. ❖ Submit the measure for classification. ❖ Publish and market the measure. ❖ Refine and update continuously.	Evaluate items
Step 8	Determine statistical properties of items scores.	Pilot the measure.		Optimise scale length.
Step 9	Reliability and validity studies.	Revise instrument.		
Step 10	Develop guidelines for administration, scoring and interpretation of scores.	Assess psychometrics (reliability & validity).		

The main similarities can be seen in determining what needs to be measured: clarifying the construct, determining items and the format of the instrument, establishing validity and reliability and refinement of the instrument. Kielhofner (2006a) was the only author who suggested the need for an assessment, and the specific target population needs to be determined before the actual starting of the process, as well as the inclusion of a pilot phase to determine any difficulties. DeVellis (2016), Foxcroft and Roodt (2013) and Shultz et. al. (2013) provided detailed instructions for item selection and development. The Rasch, as a model, is a popular approach to test psychometric properties in newly developed instruments and guides the process of item selection and refinement (Bond and Fox, 2015)

3.5 RASCH MEASUREMENT MODEL

Traditionally, the Classic Test theory (CTT) has been used in the psychometric analysis of assessment instruments to determine validity and reliability. Recently, theories such as the Item Response Theory (ITR) and the Rasch Measurement Model, which are more modern, have been implemented (Petrillo et. al., 2015; Sondergeld and Johnson, 2014).

Sondergeld and Johnson (2014) argue that the Rasch Measurement Model is a newer, rigid and better model to use for measure creation and refinement, as the model focuses on a mathematical model with specific criteria that need to be met. The model is a simple logistic model that has stringent criteria for measurements of the relationship between the person's ability and the item difficulty on a single continuum. The traditional or classic model assumes the items are all on the same difficulty level (Petrillo et. al., 2015; Velozo et. al., 2006), and this assumption limit item development to be appropriate for all the population.

Petrillo et. al. (2015) indicated that comparison between these theories is rare due to different methodologies, the different criterion set for fit analysis and the fact that different information can be obtained from the analysis. Some studies however attempted to explain the differences between these models (Bond and Fox, 2015; Hendriks et. al., 2012; Petrillo et. al., 2015); these studies revealed differences in the way data were converted and analysed to determine the scales' validity and reliability. The following table demonstrates the basic differences between CTT and the Rasch measurement model.

Table 3.2: Comparison of CTT and Rasch measurement model

	CTT	**RASCH**
Theory	Classical test theory.	Logistic mathematical model.
Assumptions	Do not consider item difficulty, as it assumes that all items are the same in difficulty.	Person ability and item difficulty are estimated together on a single continuum.
Data	Use a set of data and different models may fit the data. Exploratory factor analysis.	Unidimensional model that measures a latent trait where data need to fit the model.
Scales	Nominal/ordinal scales.	Convert ordinal data with similar characteristics of interval scales (provided the data fit the model requirements).
Scores	Use raw scores.	Data are converted to logits, which are converted to locations of person and item scores on a single continuum.
Sample	Needs normally distributed sample.	Not all requirements are dependent on distribution of the sample.
Missing data	Influence psychometric analysis.	Can continue with analysis despite missing items.
Adaptation to measure	If changes are made to the instrument, the psychometrics of the scale will change.	Able to remove/change items or persons to fit model.
Reliability	Cronbach alpha. Internal consistency reliability >0.70 acceptable.	Item fit residuals between ±2.5 are acceptable. Cronbach alpha. Person separation index (0.70 acceptable).
Validity	Sample-dependent "reliability."	Item dependent construct validity.
Bias	Separate psychometrics needs to be done for different samples, raters, etc.	Differential item functioning (DIF) to indicate bias in independent variables.

At present, CTT is still the most frequently used for psychometric analysis (Whittaker and Worthington, 2016; Sondergeld and Johnson, 2014). Petrillo et. al. (2015) and Sondergeld and Johnson (2014) claim the reason for the continued use of the CTT is that it is a simple analysis that does not need special training, it is applicable in a variety of situations and is beneficial in identifying problems in terms of missing items, and floor or ceiling effects. In a comparison of CTT and IRT, Erguven (2013) described the advantages of CTT being smaller sample sizes can be used and the analysis does not depend on the strict goodness of fit. The limitations of CTT do however seem outweigh the advantages. One limitation is that in CTT, the findings are sample and scale dependent; this makes the measure sample dependent, and it cannot necessarily be used for other populations (Petrillo et. al., 2015; Hendriks et. al., 2012). Measurement precision is affected, as the theory assumes that observable item scores are constant in terms of difficulty across the scale (Erguven, 2013) and thus not sample dependent.

Sondergeld and Johnson (2014) suggested that the Rasch Measurement Model had fewer limitations, as the analysis could convert ordinal data to interval level data, where the item difficulty is compared to the person's ability on a continuum. This view was confirmed by McCreary et. al. (2013) and Tennant and Conaghan (2007), who felt these scaling properties of the Rasch gave good measurements that can represent the person and the items on graphical maps. Another advantage is the fact that missing data do not influence data analysis, and that items or persons that over-fit or miss-fit can be eliminated to fit the model (McCreary et. al., 2013). Petrillo et. al. (2015) further added that Rasch provides more information on the various areas of the test, e.g., person ability, test difficulty, tester severity, uni-dimensionality and bias through differential item functioning.

Despite the advantages in the use of the Rasch Measurement Model, there are some limitations. As it is a mathematical model, it requires more specific training and the software available for analysis may be expensive (Sondergeld and Johnson, 2014). The fact that the Rasch model is stringent regarding fitting the model and does not take into account real-world situations was raised by Harvey (2016) as well as Whittaker and Worthington (2016) as being problematic. This means that no real-world instrument will ever fit all the stringent criteria of the Rasch Measurement Model. These authors critiqued an article by Mallinckrodt et. al. (2015), which advocated for the use of the Rasch model. Harvey (2016) explained the actual representation of data may be wrong due to the restrictions and constraints of the Rasch model and that it does not consider the variability of the underlying construct. Whittaker and Worthington (2016) agreed with this view and suggested that the relationship between items and their traits varied immensely. The model only determines the difficulty of the parameter and not the ability of items to discriminate between the underlying construct's strength and power.

Considering the advantages and limitations of both these theories, it may be a complicated decision to choose an appropriate model. Petrillo et. al. (2015) conducted a study where the CTT, IRT and Rasch models were used to analyse the psychometric properties of the same measure. Even though not all aspects of the models were used, or the fact that the analysis for each model was done in isolation, it provided valuable information. The IRT and Rasch models provided additional information from the CTT concerning areas of improvement and probable causes. Unfortunately, a limitation of the mentioned study was that data sets and the instrument may have influenced the consistency of the results and did not provide precise information on the differences between the models (Petrillo et. al., 2015). The authors recommended that the choice of a psychometric approach should be based on the knowledge of the researcher, the availability of software for analysis, the intended audience, as well as the guidelines set by the professional regulatory bodies (Petrillo et. al., 2015).

3.5.1 Requirements of the Rasch measurement model

In planning the study to develop the screening tool for sensory integration, it was decided to use the Rasch model as practical aspects such as expertise and software were available, but more importantly, when developing a new instrument, the Rasch requirements are helpful to identify exact problems in item functioning and scoring accuracy. The various assumptions or principles of the Rasch measurement model are described below.

Velozo et. al. (2006) described the core feature of the Rasch Measurement Model as the relationship of a person's ability to the item difficulty, in other words, if the measure was accurate in measuring the underlying latent trait (construct). This principle is known as uni-dimensionality and indicates the instrument is assessing the single latent trait that underlies a person's performance (Adedoyin and Adedoyin, 2013). To fit the Rasch Measurement Model, the instrument not only needs to achieve uni-dimensionality, but also needs to address category or threshold ordering, person and item fit measures and testing for local independence. Requirements further in include the Person Separation Index (PSI), differential item functioning and bias in independent variables within the sample, such as gender or age (Bond and Fox, 2015; De Klerk et. al., 2013; Retief et. al., 2013).

3.5.1.1 Threshold ordering

Firstly, raw scores for persons and items are transformed into logit values, which are used on an interval scale to plot person-items on consistent locations on a continuum (Retief et. al., 2013). The ordering of thresholds of response categories is the second step in determining if the data fit the model. By collapsing score categories, disordered categories can be ordered to fit the model requirements (Pallant and Tennant, 2007).

The category structure investigates whether the reaction or response to the items are consistent according to the latent variables (Tennant and Conaghan, 2007). Ordered response data are when a response can fall within any of the response categories, whereas the threshold is the point where the response in two adjacent categories is possible (Hendriks et. al., 2012). Disordered categories do not discriminate consistently between responses however; they can be corrected through the collapsing of categories. Different combinations may be trialled that may represent data more accurately (De Klerk et. al., 2013).

3.5.1.2 Item and person fit

According to Mills et. al. (2010), the Rasch model assumes there is a link between the person's ability to react to the item and the item's difficulty. Items are ordered according to the Guttman structure, on a continuum from less difficult to more difficult (Curtin et. al., 2016). The Rasch model further transforms raw scores for items, as well as persons, into measures known as locations (logits). Logits allow measurement, using common units on a common scale to allow for comparisons between items and respondents (Hendriks et. al., 2012). This ensures item and person fit are measured individually, but on the same continuum, and allows for generalisation of results across the sample (Curtin et. al., 2016; Hendriks et. al., 2012). Item fit statistics can be measured as a mean item fit residual score, where logits must fall within a range, from ± 2.5, for fit within the model. Person fit needs to be investigated and shows the extent to which the person's ability differs from the expectations of the Rasch model (Bond and Fox, 2015). The model calculates the person's performance on these items to determine if there were any inconsistent responses to the items, e.g. when a person scores the same value for all items in a test. A person that misfit can be deleted in an attempt to improve internal construct validity (Tennant and Conaghan, 2007). Item and person fit statistics should have standard deviation values of 1.0, with a value of less than 1.4 as acceptable (Curtin et. al., 2016; Velozo et. al., 2006). Further information on item fit statistics are provided by the chi-square value, as well as item characteristic curves (ICC) (Curtin et. al., 2016). A chi-square value of < 0.05 indicates a misfit of the data. The assumption is that there should be no significant difference between the expected values (expectations of the model) and the achieved values (data of the instrument).

3.5.1.3 Local independence

Local dependency relates to the ability of one item to influence the selection of the following item (Curtin et. al., 2016). This occurs when there is a clue in one item that will guarantee a correct response in one of the other items.

Residual correlations investigate inter-item correlations and correlations of > 0.3 show strong local dependency (Pallant and Tennant, 2007). Items with local dependence should be reviewed, reformulated or, as a last resort, deleted.

3.5.1.4 Differential item functioning (DIF)

Differential item functioning (DIF) determines whether subgroups within the sample respond different to an item and may have advantages or disadvantages in comparison to other subgroups. DIF measures the item bias for independent variables such as gender, age and culture (Retief et. al., 2013). Differences between male and female can be determined, e.g. if an item is more favourable to males than females. In such cases, items can be split in such a way that males will have a set of male-related items and females a set of women-related items.

3.5.1.5 Person separation index

Reliability is a vital component of the psychometric analysis of data, as it indicates if the instrument will obtain similar data at separate times and within different samples. The Rasch Measurement Model investigates internal consistency of the instrument by determining the person separation index that is similar to Cronbach's alpha (McCreary et. al., 2013; Tennant and Conaghan, 2007) but calculated slightly differently. Person separation index is calculated from the estimated person-locations, which are non-linear transformations of the raw scores. A person separation index of above 0.2 is needed; this will also give an indication if the instrument is able to discriminate between high and low proficiency of persons. Cronbach's alpha is the standard deviation of the raw scores and a value of above 0.85 indicates good internal consistency of the instrument (Velozo et. al., 2006). Reliability indices are sample dependent. Like all statistical models (CTT, IRT or Rasch), when the sample is not a good representation of the population, reliability indices become invalid.

3.5.1.6 Uni-dimensionality

Uni-dimensionality assumes the items measure only a specific latent trait (construct) and that item raw scores can be summed together to provide a total score (Adedoyin and Adedoyin, 2013; Retief et. al., 2013). Uni-dimensionality is determined through an equating t-test, where differences between each person are reported as a percentage of a test that fell outside the range of +/- 1.96 and should not be more than 5% (Tennant and Conaghan, 2007). Confidence intervals for Binomial tests of proportions can be used to determine if scores can be summed.

If the data still fail to fit the model, the researcher can use qualitative investigations to determine if the construct (wording) and response format are not clear enough, if the definitions used lack clarity or rating severity between raters (Shea et. al., 2009; Bundy et. al., 2001). Uni-dimensionality is usually the last step in the process and all previous tests will indicate where the problem/s lie, in which case the researcher will know exactly where to find the problem and which solutions are available.

These requirements of the Rasch Measurement Model will be used to investigate the psychometric properties of the newly developed instrument in this study and will be summarised in the methodology and results sections. Readers are encouraged to come back to these requirements for a detailed explanation of each requirement.

3.6 CONCLUSION

Occupational therapists are encouraged to use standardised assessment instruments to determine a client's strengths and weaknesses. It is important to ensure the instrument chosen is valid and reliable for the population for which it will be used. The development of a new instrument should only be attempted as a last resort and the specific guidelines for instrument development should be followed. The literature review aspired to clarify the instrument development process, as well as the theory on psychometric testing. This investigation guided the instrument development process that was followed in this research study.

CHAPTER 4: UNDERLYING PHILOSOPHY AND ASSUMPTIONS OF THIS STUDY

4.1 INTRODUCTION TO PHILOSOPHY AND METHODOLOGY

The philosophical worldview underlies the orientation nature of the research done by a researcher and informs the decisions for specific research designs used to investigate the research question. Creswell and Clark (2011: 38) reiterate that assumptions of methodologies should outline the process of research and direct the conduct of the inquiry. Specific philosophies and assumptions that underlie the methodology influenced the selection of the research design for this study. This chapter substantiates the philosophical assumptions and processes that underpinned the study.

4.2 WORLDVIEW GUIDING THIS STUDY

Creswell and Clark (2011) proposed four worldviews, or paradigms, describing the assumptions researchers make in their study and that guide how data are collected and reported. These four worldviews are the postpositive (theory verification), the constructivist (theory generation), the participatory (change orientated) and the pragmatist (real-world practice orientated) views (Creswell and Clark, 2011), and although they have some common ground, each has a different stance on how to attempt research. Differences between these worldviews are described in terms of five worldview elements namely: ontology, (the nature of reality), epistemology (study of knowledge), axiology (role of values in research), methodology (processes followed) and rhetoric (the language used in specific research paradigms) (Creswell and Clark, 2011). Creswell and Clark (2011) noted that it is possible to shift between worldviews depending on the study design or the specific phase of the study and data required to answer the research question. Alternating between designs are often used in mixed methodology, where the researcher makes use of qualitative as well as quantitative research designs. The authors did however suggest that instead of changing worldviews according to the distinct phases of the study in mixed methodology, it is best to focus on an overarching worldview where the pragmatism perspective usually fits best.

Considering the qualities of all four worldviews and the elements that inform these paradigms, the researcher chose the pragmatism worldview for this study. This worldview provides real-world practice-orientated data, focus on what will work in practice (Creswell and Clark, 2011) and guidance in the development of the screening instrument so that it can be appropriate for real-world use in clinical practice. Table 4.1. explains the reasoning and justification for this decision according to the specific worldview elements.

Table 4.1: Elements influencing the choice of a worldview (Creswell and Clark, 2011)

Worldview Element	Description from the literature	Justification for use of Pragmatism worldview
Ontology (nature of reality)	Single and multiple realities.	The study will provide multiple perspectives on sensory integration constructs that need to be measured, e.g. the researcher's views (test scores), parent's questionnaires, teacher questionnaires.
Epistemology (how can I know the reality or knowledge)	Practicality – the researcher uses whatever sources of knowledge available to answer the research question.	No specific method will be used to collect data to answer the research question. The researcher needs to be practical and flexible to gather as much data or knowledge as possible and will use qualitative and well as quantitative methods.
Axiology (role of values)	Multiple stances (biased and unbiased perspectives) Ethical stance, aesthetics, value judgments.	Standardised assessment of children is needed to provide unbiased feedback on their skills and weakness. A well-researched screening instrument will provide occupational therapists in low socio-economic environments a practical tool for use in practice.
Methodology (process of research)	Combining (mix data) several phases in the study using different types of data.	Quantitative data will be collected via surveys, screening instrument and questionnaires. Qualitative data will be collected via surveys and interviews with research assistants and experts in the field of sensory integration.
Rhetoric (the language of research)	Researchers may report on research in a formal or informal writing style.	Formal language will be used to describe the sensory integration constructs according to the specific sensory integration language in the literature. A more informal writing style will be used to describe the findings of the study in a scientific manner. The findings will be described in terms of the context where the study was conducted in.

4.3 THEORETICAL FOUNDATION FOR THE STUDY

A theoretical foundation is used by a researcher to frame the research study (Creswell and Clark, 2011). According to Creswell and Clark (2011), there are two possible theories, namely the social science theory and the emancipatory theory, that can underlie a method study. The social science theory provides the theory that guides the investigation through the questions that need to be answered (Creswell and Clark, 2011); the emancipatory theory attempts research from the viewpoint of under representative or marginalised groups, for e.g. socio-economic status (Creswell and Clark, 2011).

Within this study, the social science lens will provide the foundation for the literature review for sensory integration, child development, assessment and behaviour. This theory will be ideal to guide the researcher's investigation into low socio-economic environments and the influence this has on the child's participation in activities. The theory of sensory integration has a strong neurophysiological underpinning as it assumes that neuroplasticity in the central nervous system plays a role in the processing and integration of sensory input (Ayres, 2005).

Sensory integration theory further includes development theory, as Ayres (2005) believed that the process of integrating sensation follows a developmental sequence. The selection of items for the screening instrument will therefore be based on the sensory integration theory.

Another assumption of the theory of sensory integration is that the environment plays an important role in the processing and integrating of sensory information (Ayres, 2005). Within this study, it was especially important to consider contextual aspects. The social science theory considers the child's development within their specific context, e.g. the low socio-economic environment in which the child grew up. Social theories, such as Bronfenbrenner's Ecological systems theory (Bronfenbrenner, 2009), and Dunn et. al. (1994) Ecology of Human performance theory, were used to describe risk factors for child development within their environment.

4.4. RESEARCH APPROACH FOR THE STUDY

The mixed method research design was found to be the most suitable for this study, as it allowed the researcher to use multiple perspectives and research designs to gather data from multiple sources. Mixed method research combined qualitative and quantitative methods to answer challenging research questions and provide the researcher with a variety of research techniques (Johnson et. al., 2007). Qualitative research is used in studies where the researcher explores and explains experiences, actions and interactions of people in a particular context, whereas quantitative research tries to understand the relationship between variables (Creswell and Clark, 2011). Each design has specific characteristics and the responsibility lies with the researchers to select the best design to answer the research question. Luborsky and Lysack (2006) describe qualitative research as a beneficial approach to collect narrative data to identify and explain new phenomena, experiences and behaviour. Data gathered are only applicable to the sample of the study, results are based on the personal interpretation of the researcher and methods of triangulation should be implemented to ensure rigour. Transferability of the findings to similar situations are possible, provided the researcher gives rich descriptions of the sample, the setting and the outcomes (Creswell and Clark, 2011). Quantitative research, conversely, assumes there is one objective reality and sets out to objectively investigate the relationship between different variables using rigorous procedures (Kielhofner and Fossey, 2006). Different aspects of bias should be controlled throughout the investigations and researcher's opinions are not allowed (Creswell and Clark, 2011).

The use of a mixed method design is therefore ideal when the research question can be best answered through both qualitative and quantitative data. Teddlie and Tashakkori (2003) claim that mixed methodology has its own language and is a research design beyond just using a combination of quantitative and qualitative methods.

Creswell and Clark (2011) described six different designs for mixed method research, which included the convergent parallel design, the explanatory sequential design, the exploratory sequential design, the embedded design, the transformative design and the multiphase design. Each design has a specific order or steps in which the research needs to be conducted. Table 4.2. shows the key elements that were investigated in the choice of the study design for this specific study.

Table 4.2: Key elements that guided the choice of study design

Key elements in choosing a design	The justification for this research study design
Fixed or emergent	A fixed design was used where the quantitative and qualitative methods were identified before the implementation of the study.
Design Purpose	The study consisted of multiple phases in the development and validation of the screening instrument. Each phase had a specific design appropriate for the objectives of that phase. Data were collected sequentially, where the data of the one phase were used in the subsequent phases.
Match to research question & purpose.	The purpose of the research was to design a screening instrument for children at risk of having sensory integration difficulties in low socio-economic environments. Gathering information for the development as well as the validation of the instrument required data from various sources. Qualitative data initially assisted in a needs analysis for a new test, which led to gathering data, from experts, on items for a new screening tool for sensory integration for a specific context. A screening tool was developed and investigated for its clinical applicability and usefulness through interviews with research assistants and experts in sensory integration. The quantitative design was used for gathering specific data and described in means, modes, medians, percentages and correlations. Validation of the newly developed instrument was analysed quantitatively using the Rasch analysis, ROC analysis and other parametric and non-parametric testing.
Level of interaction	An interactive level was used as the designs were mixed before interpretation, where the qualitative data guided some of the quantitative analysis towards the end of the study.
Priority	The quantitative research design was the main research design as it was used in all three phases of the research to gather and analyse data. Quantitative data were gathered through surveys, questionnaires and direct assessment. The qualitative design was used only used in Phase 1 of the Delphi process to gain information for item development through an open-ended questionnaire and in Phase 2 to investigate the clinical utility of the screening instruments.
Timing	Sequential timing was used, as each phase of the research was dependent on completion of the previous phase. The completion of a screening instrument in Phase One was needed before the implementation of Phase 2 where the screening instrument was validated and tested. Phase 3 followed, where further psychometric testing was done on the validated screening instrument.
Mixing strategies	The mixing of the research design strategies was used to gather as much data as possible. Phase 1 was an exploratory sequential research approach, where the qualitative data collection informed the implementation of the quantitative methods. Data collection in Phase 2 followed an explanatory sequential design, where quantitative data were collected and qualitative data collected to explain the quantitative results. Phase 3 used quantitative data analysis to determine the psychometrics of the screening instrument.

Considering the above elements, the purpose and the phases of the research, the researcher found elements of the convergent and explanatory, as well as the multiphase designs, could be applied.

The researcher decided to follow a single study multiphase design with some aspects of the exploratory and explanatory sequential designs within separate phases of the study. This decision was made on the fact that the multiphase design was founded on the pragmatism worldview, that the design was interactive and there was a sequential timing in the execution of the phases of the research (Creswell and Clark, 2011).

4.4.1 Mixed method designs for the three phases of the study

Phase 1 followed an ***exploratory sequential design*** as qualitative data were gathered through an open-ended questionnaire to explore the views of experts in sensory integration on activities for inclusion in the screening instrument. The results of the questionnaire were analysed and used to design a quantitative questionnaire that further explored the use of specific activities as constructs in the design of the screening instrument. The research design converts to an explanatory sequential design for Phase 2.

Within Phase 2, the ***explanatory sequential design*** gathered data in two interactive phases. The first data collection phase consisted of the use of quantitative data to validate the screening instrument on 200 children from low socio-economic environments. Data analysis included the Rasch model to determine internal construct validity. The second phase of data collection consisted of a qualitative data collection process, through the interviewing of research assistants regarding the clinical utility of the newly developed tool. The qualitative results provided more in-depth information on the administration and scoring of the screening instrument and assisted in the refinement of the screening instrument for the quantitative data collection in Phase 3.

Phase 3 used a ***quantitative design*** as data were collected using standardised testing and analysed quantitatively. Data were used to determine the content validity, concurrent validity and sensitivity, and specificity of the screening instruments. Figure 4.1 provides a visual representation of the different qualitative and quantitative designs followed throughout the study.

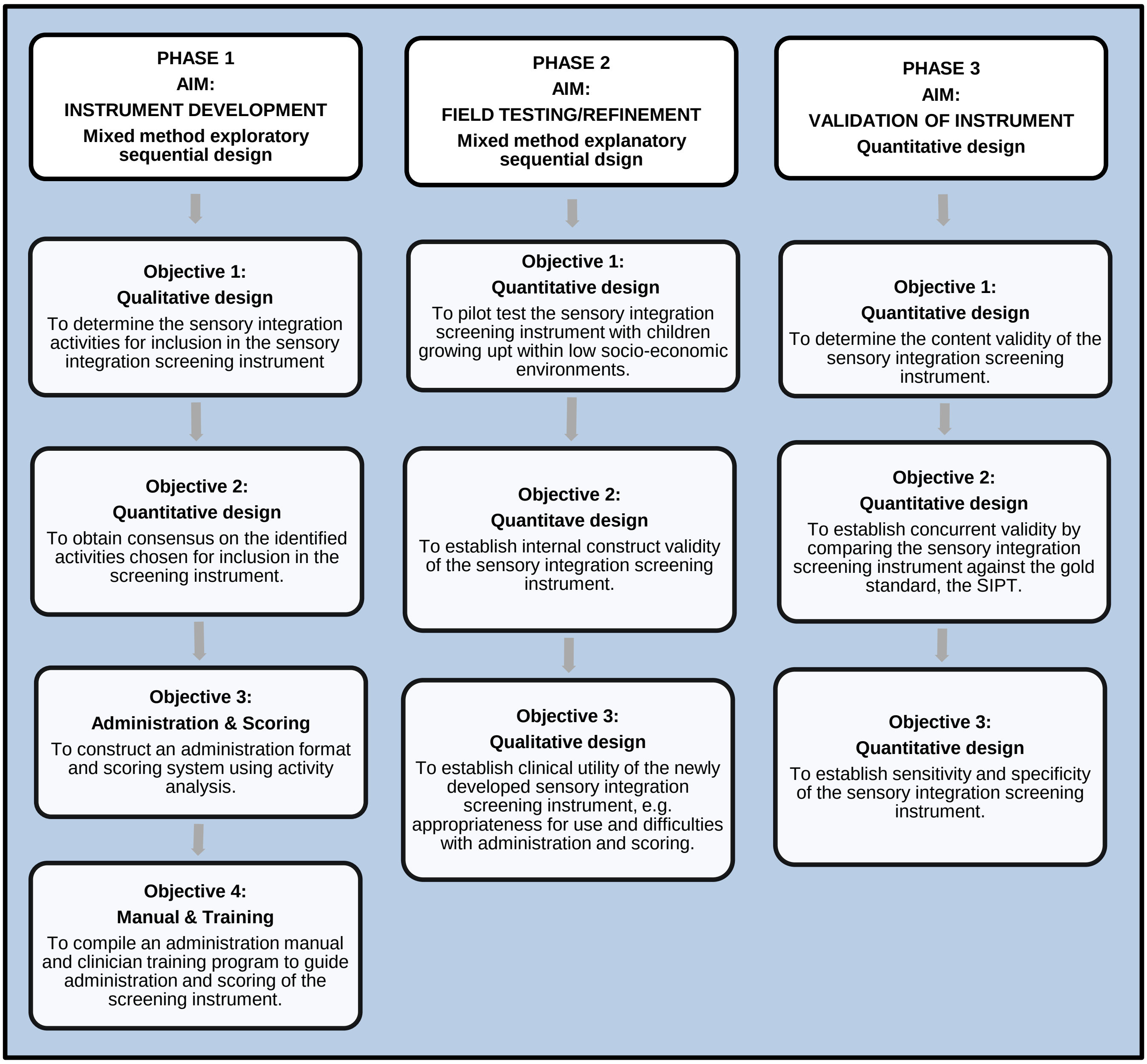


Figure 4.1: Flowchart of multiple phase designs for the current study

4.5 DATA COLLECTION USED IN THE THREE PHASES OF THE STUDY

Mixed method research study involves the specific data collection methods (questionnaires, direct assessment, interviews) that will be used to gather and analyse data (Creswell and Clark, 2011). The multiphase design guides the sampling and data collection during each phase. This design may combine sequential data collection over time with concurrent data collection at a specific time. Conceptualisation is the first step in the development of a new instrument. It is important for the researcher to delineate and define the concepts or constructs of an instrument.

It further involves setting criteria that the new instrument needs to adhere to, for e.g. the population the instrument will be designed for, the cultural context for the instrument, item development and scoring, administrative requirements as well as the psychometric qualities of the instrument. Prior to the start of the study, a content analysis was done to set criteria to guide the development of a screening instrument appropriate for the South African context.

4.5.1 Conceptualisation of screening instruments: a qualitative content analysis

The literature on the development of screening instruments emphasised the importance of being clear about the characteristics of the population for whom the instrument was developed, as well the need for the instrument (De Kock et. al., 2013; Kielhofner, 2006a; Shultz et. al., 2013; DeVellis, 2016). Switzer et. al. (1999: 406) stated that a new assessment instrument should "*be undertaken only as a last resort, after a search of existing measures of the construct has been conducted*." Various authors provided guidelines on the criteria that needed to be incorporated. They focused on contextual characteristics, e.g. the purpose of the instrument, the target population, cultural context, administration issues and appropriateness for use, as well as psychometric properties (Cook et. al., 2010; Glover and Albers, 2007; Petscher et. al., 2011; Switzer et. al., 1999). Despite the availability of peer-reviewed articles and textbooks on instrument development, there were variables in the criteria used with little consensus on the exact criteria that needed to be included. To make sense of the literature and to determine the criteria for developing an instrument, the researcher decided to do content analysis. Content analysis was chosen to investigate the literature because Seuring and Gold (2012) described this process as a flexible and methodological sound tool to investigate text. As content analysis Being an analytical tool, content analysis provides a systematic methodology to investigate the literature from psychology, education and occupational therapy fields on the evaluation and development of assessment instruments (Seuring and Gold, 2012).

To determine the process of developing a new screening instrument the researcher undertook to do the following in the content analysis:

- ❖ Determine the most important criteria from current literature that would guide the evaluation of existing instruments, as well as guide the development of the new instrument.
- ❖ Develop specific criteria for the assessment of existing assessment instruments, as well as guide the development of a new screening instrument.
- ❖ Critically appraise existing assessment instruments for sensory integration difficulties in terms of the criteria described in the literature.

4.5.1.1 Data collection procedure

1. A literature search was conducted to gather material for analysis. Specific inclusion criteria guided the collection of the literature:

- English literature from peer-reviewed articles, policy documents and instrument development guidelines from 1990 to 2017.
- Documents that focused purely on the theory of the instrument development process were included and papers describing the developmental process of a specific newly developed instrument were excluded. The reasoning for this was to ensure that the information analysed focused on the test development process only and was not influenced by the specific constructs that were discussed within a specific instrument.

2. The data collection procedure were conducted as follows:

- The literature search used electronic databases such as EBSCO host, ERIC, CINAHL, Google Scholar and PUBMED to search for instrument development. Search terms used were *"test development," "psychological testing," "assessment measures," "screening assessments," "scale development," "instrument development," "measurement"* and *"assessment tools."*
- The literature generated further search terms using *"testing in South Africa," "cultural testing," "validity," "reliability," "psychometrics"* and *"test administration."*
- Forty-six documents were found based on the search terms. The specific articles were further analysed through the perusal of the paper abstracts to decide on suitability for inclusion in the content analysis. The final literature used for the content analysis included 43 articles that consisted mostly of peer-reviewed articles, assessment reports and instrument design guidelines.
- The papers were downloaded in pdf format and saved in an allocated file.

3. The researcher read the articles to collect key words on instrument development and assessment that could be used as codes for the content analysis.

4.5.1.2 Data Analysis

A qualitative software programme, MaxQDA Analytics Pro (VERBI Software GmbH., 2016), was used to analyse specific codes within the selected papers.

- Specific keywords on instrument development were identified from the literature and used as codes for the qualitative analysis. See Figure 4.2 for the codes used in the content analysis.
- The codes were generated within the software programme and a lexical search was done of all the papers to determine the number of times the specific codes were cited within each of the documents.

- A code frequency table was exported from the software programme to determine the frequency a specific code was cited within a specific document.
- The frequency of the code was interpreted as the importance of the keyword in instrument development and therefore included in the development of criteria.
- The codes were further analysed to provide meaning to the findings and to guide the criteria setting process. Similar codes were clustered together to form meaningful categories. See Figure 4.3 for the mind map on the organisation of the codes.

4.5.1.3 Results for content analysis

Figure 4.2 gives a visual representation of the frequency of codes or criteria for instrument development within the literature. The rows, or vertical axis, indicate the codes, and each column or horizontal axis indicates the analysed papers. The number in the area where the code and paper connect indicates the frequency, in numbers, that the code was cited within the specific paper. The total number at the end of each row indicates the overall number of times the code was cited within the literature search.

The codes cited most frequent were validity (1234), cultural (1160), screening (949), language (857), items (786), reliability (755), measure (646) and responses (506). Variables discussed the least were demographics (17), equipment (23) ethics (26), financial (30), contextual (43), resources (78), cost (88), materials (89), environment (94), format (97) and gender (98). The codes generated through the analysis process measured the frequency that these code words, or key terms were cited within the literature. By determining the frequency of citing of a code, the researcher gained information on the importance of these criteria in test development. The initial planning was to include only codes that had the highest frequency, yet this was not possible as important key terms were cited infrequently. Interestingly, the codes mentioned the least were considered equally important and the researcher included these codes in further analysis. An in-depth analysis identified nine categories of criteria for instrument development. Codes with lower frequencies were included in these categories to give more meaning to the findings.

A mind map was used to analyse codes into further categories to make more meaning of the findings. Seven categories emerged and included the purpose of the instrument, the proposed population, cultural influences, and construction of the items, administration, scoring and psychometrics (Figure 4.3). The first branch of the mind map shows the categories, the second branch shows the codes that fit within the category and the final branch following the code shows the researcher’s reasoning on how the code could link with the context of the screening instrument that was in the development process.

4.5.1.4 Determine criteria for instrument assessment and development

Following the content analysis, a set of criteria was developed to guide the critical appraisal of existing sensory integration assessments for use in the South African context and to guide the development of a new screening instrument. The seven categories were used as the overall descriptors for the criteria. Not all the codes were included as codes with similar meaning were found, e.g. materials and equipment. Some of the less cited codes were included in the criteria as the researcher argued that these were necessary for inclusion in the South African context. It is necessary to know the population the instrument would be administered to, consequently the age and the gender were included in the criteria. Details on the administration of the instrument were not frequently discussed yet it was essential to consider the language of instruction, the length of the test, the equipment needed and the cost thereof. Equipment and the cost are frequently problematic within the public health sector where the screening instrument will be used. The scoring of instruments was not widely discussed in the literature, yet it was important to set criteria for scoring to ensure the complexity or type of scoring did not increase the burden on the administrator. The psychometric properties, such as validity and reliability, of an instrument were mentioned the most frequently in the literature search and are important to determine if an instrument will be feasible for use.

Code System																																														
contextual	2				1				2			2	7	3								6	11			1	3												3							2	43
methods	2		1	1	2	1	10	2	3		28	1	4	6	3			15	6	6	2	18	7	2	10	35	16	8	7	1	11	1	24	10	2	1	5	3	3	3	4	1	2	7	1	4	279
analysis	31	2	5	14	2	2	9	1	4	10	8		2	64	8	2	11	16	8	10		6	31		8	50	35	8	10	21	14	5	6	4	12	12	2	7	16	1	2	8	5		1	7	480
training	8	1		1	7			5	20		1	6	12	8	24			1	6	2	2			1	2	166	18		3	15		2		1			2	1	1	1	8		1	2	1	6	335
demographic				4						2					1								1			5	2						1	1													17
variables	1	1	4				1			7	1	1	1		8		3	3	2		1	6	11		2	1	102	1	6	1	9	2			8	1	1	20	3	3		7		1		4	223
responses	15		3	2			1		2			10	2	5			1	5	1			7			3	17	361	2	7	22	3	2	6	2	14			8	2	1	1	1					506
measure		5	4	28		6	9	4		10	21	7	2	2	73		1	69	33	14	10	79	3	1	1	19	9	3	18	4	29	17	2	8	15	43	11	14	5	18	1	18	7	3	16	4	646
format	2		1				1			1		7	1	1	3			7				4			15	8	8	1	2			8			4		1	2		1		1	1	17			97
accuracy	2	3	4	2		2	12			8	39			6	2				7		12				1	4	2		1	18		8	1			88	1	6	18		1	3		1		2	254
sensitivity	2	4		4		2	2	1	1	6	49	1			15				13	3		1	1		2	1	7			2		20	1	6	14	62		2	3		2	10				1	238
specificity		4				2	2			6	50				11			1	11								1			1		16		3		57			3			10			1		179
environment	1			9						3		1		1			1	1		2	1		4			9	28	1		12		4					1				2	5	8				94
population	2		15	5	10	5	2	1	4	1	72	5	4	1	6	3	1	38	8	4		12	3		11	31	19	3		4	5	10	12	19	9	4	3	1	1	4	1	5	1	2		8	355
age	2		3	30		3	3		1	63		2	1	1	33	2	20	3	7	1	1	5			1	19	9	1		36	1	9	8	107	11	2	21	6	2		5		1			20	440
gender	5		15	4		1			6					2	1				2			12			1	14	2	2		1	1	1	9	1	3			5	2		1	1	1	1		4	98
cultural	82		2	13	10				56	2		35	25		26		8		8			9	186		68	68	257	66		37	5		74	23	16		26				32		16			10	1160
culture	33				1				23	1		3	7	1	10		4		3			3	14		5	49	151	13		30			3	1	2		9	1			27		15	2		1	412
language	21		1	3	3				1	3	2	4	14		45		3		20	1		4	1	6	41	171	206	10	2	68		1	79	6	3	8	88	1	3	2	28		2	5		1	857
procedure	4		1		1		2			2	3		1	5	7		1	8	1	1					1	9	76	3	2	22	1	1	2	2	4	4	1	1	3		1			11		1	182
instructions	5		1		2									5			4	3			1					2	44	3	1	6		2	19	4			2	1			9	2	1	10		4	131
administration	4	1	25	5			1				4	2	3	16	21		4	22	1		3	5		4	5	17	78	8	6	13	4	22		1	3			1	3	2	3	3	3	6		6	305
financial		1			1			2			1	2	1	1					1							8	5							1	2				2							2	30
cost				3	1	1	2	3				1		1				1	9		2	4	1			24						3				3		1	11	1		12			4		88
equipment		1												1			1				12					3								1				1					3				23
materials				1								9	8	5	5		2		3						2	9	8			4		2	1	4			4	2			1		4	9		6	89
resources					3	1	1	2	2		2	1	6	9	4			1	1	3		3			1	8	3	1	1		3	6			1	2		1	2	1	1		2	1	3	2	78
standardized				2	2		2			2	1	2	5	17	10			1		2		1		2		22			1	1		1	3	13		3	1	2			2				5	1	104
ethics			1		5		2		2			1	1	1				3								1		1		3				1		1					1		1			1	26
characteristics	2					1	1	3		5	3		1	5	1			3	2	1		9	4		6	16	27	4			1	5			2	1		1	3	3	1	1		8		7	127
criteria	1	1		1		2	3	76			3		1		6		1		3	1	15	3			1	17	10	1		24	6	8	1	2	1		1	6	2	2	4	2	1	22		2	230
items		1		29	4	2	14			8	1	27	2	20	16		17	143	4	1		58	10		29	11	4	12	19	25	41	14	33	21	29	1	4	57	4	26	9	17	2	62	1	8	786
constructs	2			1		1	3			1			3				1	13	2			5	5		7	22	6	4	8		6	11			3			7		1	2	12			2	2	130
psychometrics				11	7	7	4			24	1	5	7	2	17		2	1	5			32		2	2	45	9	11	21	2	47	3	6	1	2	2	1	3		6	10			4		6	308
reliability	1		1	29		8	41	4		1	1	1		10	71		4	91	37	13	33	45	2	7		36	14		52	34	55	18	3	18	5	1		13	5	21	1	30	2	38	2	7	755
validity	3	1		49	1	23	35	2	1	6	6	7		1	70		11	81	62	11	13	56	5	30	5	48	24	8	97	7	115	41	16	5	4	7	2	231	12	31	1	53	2	44	2	5	1234
criterion				3		7	3	4		1	44			1	1			7	5	6		17		2	16	5	2		3	4	39	18		3		32		19	3	9		9	1	35			299
criterion				3		7	3	4		1	44			1	1			7	5	6		17		2	16	5	2		3	4	39	18		3		32		19	3	9		9	1	35			299
norms	1	1			2	3				3	1	1	2	2	15		5		4		1	2		2	3	95	29	5		2		14	2	2			4				11			27			239
scoring	3			7			4	2				1	1	81	5		2	2	4		2			3	5	2	32	2	5	30	2	4	1	1	2	3		8		1			2	8	1	1	227
diagnostic	1	3		5		10	20			3	61				2				8	7		10		1		29	8		2			5				5		3	4	3							190
screening		20			1	28	2			20	20			2	55		1		329			4				10			2	1		138		3		100	4	3	97	1	3	104			1		949
purpose		1	1	42		2	1	9			2	1		3	1		4	22	1	7	2	3		8	10	39	36		2	4	2	4	6	2		2	2	5	2	3	3	3	6	4			245
SUM	238	51	88	311	66	127	196	125	128	200	469	146	124	290	577	7	113	568	622	102	113	446	300	73	280	115	165	182	281	459	439	444	319	280	171	477	197	462	221	154	178	327	91	365	41	135	378

Figure 4.2: Visual representation of the frequency of codes or criteria for instrument development within the literature

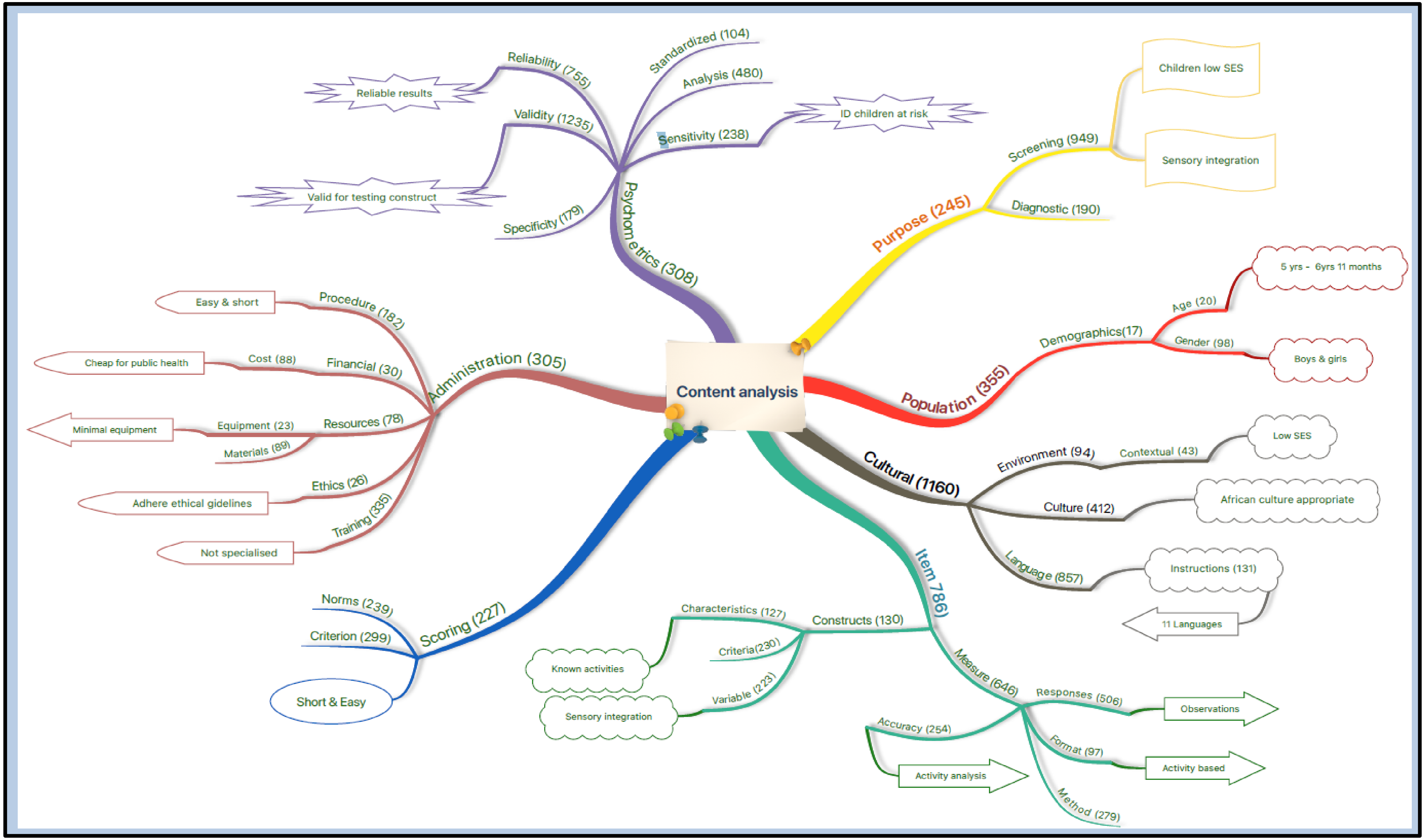


Figure 4.3: Mind map of further interpretation of the content analysis

Table 4.3: The criteria developed to guide the development of a screening instrument

Criteria	Description of criteria for instrument development in the South African context
Purpose of instrument	❖ Underlying construct: To determine if children from low socio-economic environments are at ***risk of having sensory integration difficulties***. ❖ **Type** of instrument: Is it a screening instrument or a diagnostic tool?
Population	❖ ***Gender:*** Male and female ❖ ***Age:*** 5 years 0 months - 6 years 11 months This age group was chosen for the following reasons: - It would be beneficial to identify problems earlier in the school environment to arrange for intervention. - According to a pilot study done at a hospital in the North-West province, 70,3% of the children referred for services were between five years and six years 11 months (Van der Linde, 2009). - This is traditionally the age group where children attend school for the first time in South Africa and are identified as having difficulties and referred for occupational therapy intervention (Van der Linde and Olivier, 2010). - The age range for using the SIPT test (the gold standard test) is within 4.0 years – 8.11 years of age (Ayres, 2004)**.**
Cultural context for instrument	❖ ***Environment:*** Children from low socio-economic environments. ❖ A culturally appropriate instrument that is more occupation based can be used across different South African cultures. ❖ **Language:** Minimal verbal instructions or the use of demonstration is required to make sure that children of all 11 South African languages can be assessed.
Item development & scoring	❖ Constructs that are known and appropriate across a variety of cultures. ❖ Item to measure sensory integration. ❖ Activities based format needs to be known in children from low socio-economic environments. ❖ Observations based on purposeful tasks will be more appropriate to use across diverse cultures. ❖ Activity analysis to develop scoring. ❖ Short and easy scoring.
Administration requirements	❖ ***Access to services:*** Children from low socio-economic environments access occupational therapy services at government hospitals or clinics. These services are mostly provided by community service occupational therapists with basic sensory integration knowledge. ❖ ***Length:*** A short test that can be completed within one visit to the occupational therapists (less than 1 hour). ❖ **Cost:** Inexpensive and cost effective, as money for expensive instruments is not available in the community at hospitals/clinics. ❖ **Equipment:** equipment needs to be cheap and transportable so that occupational therapists working in the community can easily transport the instrument to various clinics. ❖ **No specialist training**: The instrument needs to be available for use to occupational therapists who do not have specialist training in sensory integration. ❖ The instrument should not place an unreasonable burden on the occupational therapist regarding administrating or scoring the instrument.
Psychometrics	❖ The instrument needs to be psychometrically sound. ❖ Valid for use in the South African context and children living in poverty ➢ Content validity ➢ Construct validity ➢ Criterion validity. ❖ Reliable use in the South African context and for children living in poverty ➢ Internal consistency ➢ Test-retest reliability.

The content analysis of the literature and the resultant criteria guided the phases of the study. These criteria were especially valuable in Phase 1 with the development of the screening instrument test criteria, to remind the researcher of the aspects that need to be included in the screening instrument.

The overarching construct for measurement in the screening instrument was sensory integration. Sensory integration as a construct was defined following the literature review on sensory integration theory. This literature review attempted to determine the specific components or domains of sensory integration (Ayres, 1989; 1972a; 2005; Mailloux et. al., 2011; Mailloux et. al., 2018; Smith Roley et. al., 2001a; Schaaf and Mailloux, 2015). Nine components of sensory integration were derived from sensory integration literature and used to guide the clarification of the sensory integration construct. Each sensory integration component was defined and described in detail. Each component was further broken down into the specific element of sensory integration that contributes to the specific component. These elements of sensory integration were further defined in terms of the role they played in sensory integration and how they affected function (See appendix A). The sensory integration components were used to form the domains within the screening instrument.

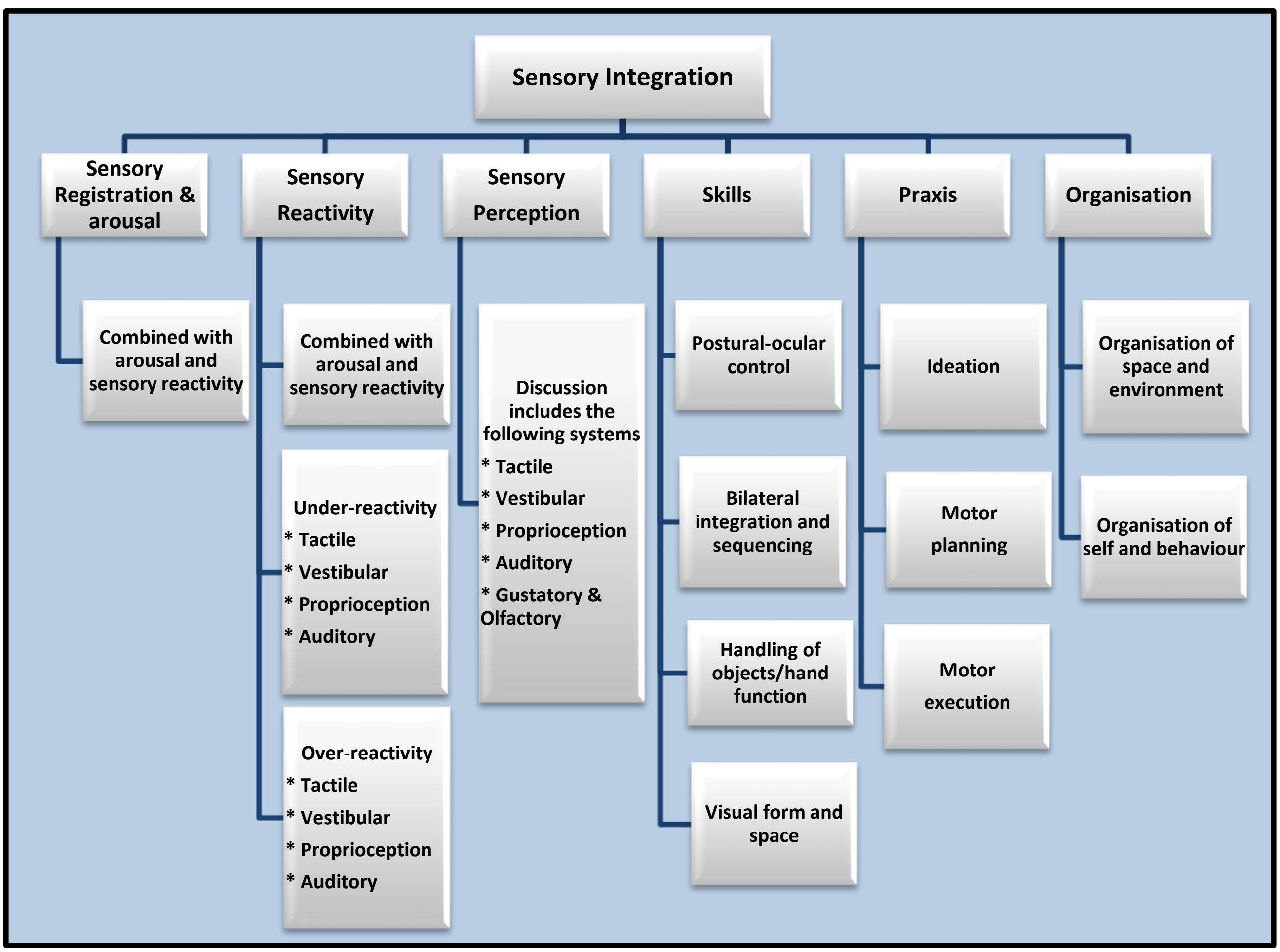


Figure 4.4: Sensory integration components included in the screening instrument as domains(Smith Roley and Schaaf, 2006)

4.5.2 Data collection phase 1

The data for Phase 1 of this study were collected using the Delphi process. Initially, qualitative data were gathered from experts in sensory integration, who completed an open-ended questionnaire. Results from the first qualitative survey guided the development of the second questionnaire for data collection. The second round of the Delphi process consisted of a quantitative questionnaire, which asked experts to choose activities they found useful for observing sensory integration difficulties. Activities that reached a consensus of 70% or higher were included in the screening instruments. These activities were developed into step-by-step observations for scoring using activity analysis. The methodology, results and discussion for Phase one will be described in detail in Chapter 5.

4.5.3 Data collection phase 2

During Phase 2, quantitative data were gathered through the field-testing of the newly developed screening instrument. The scores from the testing were analysed using the Rasch model to determine validity and reliability. The results from the Rasch analysis were used to refine the internal validity and reliability of the screening instrument. Following this process, qualitative data were obtained on the clinical utility of the screening instruments by interviewing the research assistants and experts in sensory integration, who were asked to review the screening instrument's clinical utility in terms of applicability, usability, appropriateness of observations and scoring. The interviews were analysed through thematic analysis and the results were used for further refinement of the tool. The methodology, results and discussion for Phase 2 are described in detail in Chapter 6, and the results of the Rasch analysis, as well as the interviews with research assistants, are discussed in Chapter 7. On completion of Phase 2, Phase 3 was implemented to validate the screening instrument.

4.5.4 Data collection phase 3

Quantitative data gathering in Phase 3 consisted of the administration of the newly developed screening test and the Sensory Integrations Praxis Tests (SIPT). The data from these two tests were analysed and compared to determine convergent validity. Psychometric properties of the screening instrument were determined and analysed. The methodology, data analysis and results will be discussed in Chapter 8.

4.6 ETHICAL CONSIDERATION FOR THE RESEARCH STUDY

The PhD assessors group of the University of the Witwatersrand and the Human Research Ethical Committee (Medical), Approval, approved the study no. M120359 (Appendix B). Each phase, which had specific ethical requirements, will be discussed in detail in the relevant chapters.

Research integrity was maintained in the following way:

- Ownership: Ownership of the data belong to the research institution, the University of the Witwatersrand, and needs to be treated as such.
- Reliable data: To ensure that data are valid and reliable, the researcher adhered to the scientific guidelines of the research process and the research methodologies as set out above. The research assistants who assisted with the assessment of the children were well trained before data collection, a standardised manual was provided for testing and standardised equipment was used. The researcher provided each research assistant with a test kit that contained the required equipment and documentation for the administration of the screening instrument.
- Fabrication and falsification: Care was taken to ensure that data were not made up, fabricated or manipulated in any way during the research process.
- Data protection: Data were captured electronically and kept on a computer that was protected by passwords and the university's firewalls. Hard copies of the data were locked in a cupboard in the researcher's office, and only the researcher had a copy of the key.
- Plagiarism: The researcher attempted to avoid plagiarism by not using ideas from other author's, or by citing the author to give credit. The final written documents were submitted to Turnitin for plagiarism detection.

4.7 CONCLUSION

In this study, the researcher opted to use a mixed methods approach with an exploratory sequential design for Phase 1, an explanatory sequential design for Phase 2 and a quantitative design for Phase 3. The theoretical grounding from the assorted designs in each phase ensured a carefully planned and rigorously executed study.

The qualitative content analysis used to conceptualise the method for developing screening instruments was done to provide practical guidelines to conduct the study. It is unusual in instrument development studies to commence with conceptualisation of the methodology before commencing with the aims of the study; however, the researcher was overwhelmed by the myriad of the literature available on instrument development. The researcher decided to address the problem in a systematic way, hence the inclusion of the qualitative content analysis.

The selection of assorted designs and strategies in the study, as allowed by the mixed methods approach, enabled the researcher to gather data from multiple sources using various viewpoints, to analyse the different data sets appropriately and arrive at valid, reliable and trustworthy conclusions without endangering the integrity of the study. The next chapter will explain the methodology for each aim of the research in detail.

CHAPTER 5: METHODOLOGY

5.1 INTRODUCTION TO METHODOLOGY

The aim of the study was to develop a sensory integration screening tool for use by newly qualified occupational therapists working in public health, who are not formally trained in sensory integration. Crocker and Algina (1986), DeVellis (2016), De Kock et. al. (2013), Kielhofner (2006a), as well as Shultz et. al. (2013) described specific steps and guidelines in the development of assessment instruments. Based on the guidelines from these texts, content analysis was used to construct an instrument development process to guide the research. The research methodology for the development and validation of the sensory integration screening instrument consisted of three phases. Phase one comprised the operationalisation of test development and included item development, administration manual development and the training programme for administrators. Phase two consisted of the pilot testing of the newly developed screening tool and determining the internal construct validity of the instrument. Finally, Phase three consisted of the validation of the screening instrument to determine selected psychometric properties. The methodology used for each phase will be described in this chapter followed by the results in Chapter 6.

5.2 METHODOLOGY OF PHASE ONE

The purpose of the sensory integration screening instrument is to identify children at risk of having sensory integration difficulties in low socio-economic environments. To follow a sound and rigorous methodology for instrument development, the researcher analysed the literature available on the subject and set specific criteria for an instrument to be used in the South African context. The criteria included a cost effective tool that required minimum equipment, and that was psychometrically sound to identify children at risk of having sensory integration difficulties. DeVellis (2016) described a screening instrument as a short cost-effective tool used to determine if children are at risk for specific difficulties, whereas a diagnostic tool is a more in-depth assessment to determine a specific difficulty and the severity of the problem and can only be used by a specifically trained professional. Based on the purpose of the instrument, as well as the criteria the instrument needs to adhere to, the researcher decided on the design of a screening instrument, as it fit with all the requirements and the existing need. A sensory integration screening tool will be ideal to use in resource-deprived areas, such as public or rural healthcare settings, as it will be short, cost effective and require minimum equipment and materials.

The aim of Phase one was to develop the items for the screening instrument identifying sensory integration difficulties in children aged 5 years 0 months to 6 years 11 months, from low socio-economic environments. Four objectives were set to reach this aim:

- Objective one set out to explore and identify the sensory integration activities for inclusion in the sensory integration screening instrument.
- Objective two focused on obtaining consensus on the suggested activities chosen for inclusion in the screening instrument.
- Objective three focused on constructing an administration format and scoring system using activity analysis.
- Objective four was to compile an administration manual and clinician training programme to guide administration and scoring of the screening instrument.

5.2.1 Study design Phase one

The study design used for Phase one was a mixed method exploratory sequential design. A mixed method design provides the opportunity to draw on the strengths of both qualitative and quantitative designs to gather data (Tashakkori and Creswell, 2007). Creswell and Clark (2011) described this design as useful when there is a need to develop a new test when none is available. An exploratory sequential design utilises two phases and starts with qualitative data collection to generate and analyse new ideas, followed by a quantitative phase to generalise the initial findings in the qualitative phase (Creswell and Clark, 2011).

5.2.2 Objective 1: To explore and identify the sensory integration activities for inclusion in the sensory integration screening instrument

Crocker and Algina (1986) proposed that one of the first steps in instrument development is to identify the behaviours that represent the underlying construct. The researcher proposed the use of participation in activities for the observation of sensory integration behaviours. The Delphi technique was used to explore and identify the sensory integration activities that would provide observable behaviours of sensory integration.

5.2.2.1 Population and sample for Delphi technique Round 1

The population consisted of occupational therapists trained in sensory integration. Purposive sampling was used to select a panel of experts in sensory integration, as Etikan et. al. (2016) stated that purposive sampling was an appropriate technique to use when the researcher deliberately wants to include participants who are well versed in the topic being explored. It was thus important to ensure the experts had some related background, knowledge and experience on the topic (Day and Babeva, 2005; Okoli and Pawlowski, 2004).

Inclusion criteria for panel of experts for Delphi Round 1

Experts in sensory integration were identified by considering the following inclusion criteria:

- Members of the South African Institute for Sensory Integration (SAISI), who completed their full training in assessment and intervention in sensory integration.
- Experts were to have at least 3 to 10 years of experience in the use of sensory integration as an approach.
- Experts were practicing in the field of paediatric occupational therapy at the time of the research.
- Experts were to be familiar with the administration of the SIPT and other standardised assessment tools.
- Experts in sensory integration who were involved in the training of students in sensory integration by lecturing on a SAISI course, or in the marking of a SI protocol that forms part of the SAISI qualification process.

Using the set criteria, members of the SAISI board, lecturers on SAISI courses and SAISI protocol markers were identified to participate in the study. This resulted in a sample of 35 participants. These participants were approached for participation through SAISI via email (see Appendix C) and the data collection questionnaire was sent to them for completion.

5.2.2.2 Data collection tools and procedure for Delphi Round 1

The Delphi technique was chosen for data collection as it is a structured, methodologically sound process to reach consensus regarding the inclusion of an item into the screening instrument (Okoli and Pawlowski, 2004). As the Delphi technique was reported to be flexible, cost and time effective and provided the opportunity to include experts countrywide, it was considered an appropriate technique (McGinnis et. al., 2010; Gill et. al., 2013; Okoli and Pawlowski, 2004). Expert judgement was employed as a technique to gather information during Round 1.

Experts were asked to complete an open-ended questionnaire to explore information on the underlying behaviours describing sensory integration, as well as activities that would provide observations of these behaviours (Crocker and Algina, 1986). The researcher developed a questionnaire with open-ended questions based on information from the literature and other tests that included sensory integration constructs and activities (Appendix D). The first part of the questionnaire requested demographic information from the participants, the second part requested the participants to describe activities they will use to observe/assess sensory integration difficulties within the different areas of sensory integration, and part three consisted of questions on the proposed administration and scoring of the screening instrument. As the questions were open-ended, the participants were not guided in choosing specific problematic areas and could present any information of importance, according to their knowledge and experience.

The questionnaire (Appendix D) was emailed to participants using SurveyMonkey® (SurveyMonkey Inc., 2012), an online tool used to set up specific questions and to send out the questionnaires, allowing participants to complete the survey anonymously (SurveyMonkey Inc., 2012). Gill et. al. (2013) described using an electronic tool as a quick, low cost and efficient way to send out questionnaires to participants that may result in quicker data collection. An email was sent out through SurveyMonkey® to each identified expert, to request participation in the study. The e-mail included an information letter (Appendix C) on the study and asked for permission for participation. Participants were not required to sign a permission letter for participation in the research, as the completion of the questionnaire was taken as consent for participation. The participants had a two-month response time to complete the questionnaire and a reminder was sent via email two weeks before the closing of the questionnaire. Following the due date, the questionnaire was closed, and information was exported from SurveyMonkey® to an Excel spreadsheet and graphs for analysis.

5.2.2.3 Data analysis for Delphi Round 1

A content analysis framework was used for the first round of the Delphi process, as this allows for the detailed exploration of specific themes in written text, e.g. the open-ended questionnaire (Bengtsson, 2016). A six step analyses, described by Creswell (2009), derived from the eight step coding process by Tesch, was followed.

- Step 1: Data were organised and prepared for analysis by downloading an Excel spreadsheet from the SurveyMonkey® site. This Excel spreadsheet was saved for further analysis.

- Step 2 involved the reading of the participants' answers to get a general idea of their feedback. Due to the poor depth of feedback, a profile matrix was developed for analysis of the data rather than using formal data analysis software. The open-ended questions were analysed by creating a profile matrix on an Excel spreadsheet, where each category was reflected in a row with the responses of each participant next to the questions. Kuckartz (2014) found the use of a profile matrix useful to get clear and comprehensible information in a qualitative analysis. The categories included the sensory systems, sensory modulation, sensory discrimination, motor skills difficulties and praxis. These categories were identified based on sensory integration literature. Within the matrix, responses from each respondent were organised in a separate column to facilitate comparison of questions between the respondents.
- Step 3 included coding of the data. The researcher investigated each category by sorting information into specific themes, using colour coding. The codes were selected based on the sensory systems involved in the categories according to the sensory integration literature. The aim of the open-ended questionnaire was to gather data on the activities that could be used to observe or assess for sensory integration difficulties. Activities that were similar between at least two of the participants were highlighted in specific colour codes. Following the coding of the activities, a summary table was created on an Excel spreadsheet to compare the activities identified for each category and theme. The following colour coding was used:
    - Purple – observations or clinical observations.
    - Blue – vestibular activities and motor skills.
    - Yellow – visual activities and perceptual skills.
    - Green – proprioception activities.
    - Red – tactile activities.
- Step 4 involved the analysis and description of the participants and background information, namely age, highest level of training, years of experience in occupational therapy and years of experience in sensory integration, were gathered from participants feedback. The background information was analysed using Excel's statistical functions, providing descriptive statistics such as means and percentages.
- Step 5 involved the identification and description of the activities and observations from the profile matrix for inclusion in Round 2 of the Delphi technique.
- Step 6 involved the verification of data analysis and findings by a colleague. This process was followed to encourage the establishment of trustworthiness and validity of data. Elo et. al. (2014) encouraged the establishment of trustworthiness, through the verification of data using double coding, or peer review of the data.

5.2.3 Objective 2: To obtain consensus on the suggested activities chosen for inclusion in the screening instrument.

Objective 1 identified one overall theme that focused on the use of observations to determine sensory integration difficulties. As the first round of the Delphi process did not provide enough activities to choose from, more activities were identified from the literature and existing assessments for inclusion in the second round of the Delphi technique. The activities from the literature and existing assessment were chosen based on the instrument development criteria set in Chapter 4. The activity inclusion criteria were as follows:

- Activities that are familiar to the population. As occupational therapists working in public health do not have access to expensive resources, activities require as little equipment as possible or only equipment available within a child's house or the clinic. The literature indicated that children from low socio-economic areas do not have access to the same equipment as children from high socio-economic areas (Noble et. al., 2006).
- Activities that are age appropriate, as a child from 5 years 0 months to 6 years 11 months should be able to do the identified task without assistance.
- Activities needed to involve as little verbal instructions as possible. The reason for this was that South Africa has eleven official languages and the activities need to be accessible to all children no matter what language they speak (Laher and Cockcroft, 2014).

5.2.3.1 Population and sample for Delphi Round 2

The population for Objective 2 was the same as in the first Delphi round and consisted of experts in sensory integration. Please refer to 5.2.2.1 above.

5.2.3.2 Data collection procedure and tools for Delphi Round 2

The questionnaire in the first round of the Delphi technique explored the expert panel's opinion on the type of activities that could be used to evaluate sensory integration difficulties, whereas the questionnaire in the second round asked the panel to choose specific activities that could be used for assessment of sensory integration. The data collection tool for Round 2 of the Delphi process was a questionnaire that was developed using the findings from the questionnaire in Round 1, the characteristics of instrument development identified in the content analysis, as well as additional activities from the literature and items from other assessments (Appendix E).

The activities described in the questionnaire were grouped in four types of activities, namely activities of daily living, school-type activities, motor-type activities and play-type activities. SurveyMonkey® was again used for the distribution of the second questionnaire (Appendix E). The expert panel was asked to choose from specific activities that they would use as items for measuring sensory integration. An e-mail reminder was sent out to participants two weeks prior to the due date to improve the response rate.

5.2.3.4 Data analysis for Delphi Round 2

The data were collected from SurveyMonkey® by downloading the responses onto an Excel spreadsheet. The data were analysed in Excel, totalling the number of times an activity was selected and the percentage calculated. Graphs were generated for each of the four types of activities. Acceptance of an activity for inclusion in the screening instrument was based on the overall frequency the activity was chosen by members of the expert panel. To ensure rigour in the item selection process, the degree to which experts reached consensus on the relevance of an item to the construct was set at 70%. McGinnis et. al. (2010) set a similar level of consensus in a study on assessment of balance.

5.2.4 Objective 3: To construct an administration format and a scoring system using activity analysis

Six activities were identified during the second round of the Delphi technique in Objective 2. Objective 3 focused on analysis of the six activities, which were broken down into specific observable tasks and actions to complete the activity and the underlying sensory integration domain for observation (Crocker and Algina, 1986). As the findings of the first objective indicated the importance of using clinical observations in the assessment process, the researcher chose to use an occupational performance-based assessment format, which uses specific observations as a measure of the demands of the activity and the underlying sensory integration domain. Thorley and Lim (2011) considered the use of an occupational performance-based assessment to be more appropriate for culturally diverse populations.

Activity analysis was done according to the activity and occupational demands guidelines, as described in the Occupational Therapy Practice Framework (AOTA, 2014). The activity analysis firstly investigates how the activity was accomplished or executed.

The process further investigates the meaning of an activity for the child, the tools and resources needed to execute the activity. Secondly, the activity analysis investigated and described the underlying sensory integration demands according to nine sensory integration domains. The activity analysis finally guided the breakdown of the activity into a sequence of tasks that require the completion of specific actions. Fisher and Jones (2010) proposed that these actions be observable and provide information on the performance of the client. The execution of these actions was measured against the sensory integration observations for the nine sensory integration domains.

5.2.4.1 Description of how the activity was executed

Each activity chosen stated the name of an activity but did not provide detail on the execution of the activity. The researcher used clinical knowledge of the developmental expectations of the specific age group and sensory integration theory to expand on the execution of each activity into specific tasks to make it more meaningful for the child. See 6.2.3.1 for the description of how the activities are to be executed.

5.2.4.2 Description of underlying sensory integration domains

To determine the underlying sensory integration challenges for each activity it was important to define each sensory integration domain and provide examples of possible observations to guide the tasks and actions in an activity for scoring purposes. Smith Roley et. al. (2001a) described six overarching components of sensory integration, which are divided into smaller domains. Based on these components and underlying domains, nine domains of sensory integration were derived to guide the defining of the sensory integration construct (Ayres, 1989; 1972a; 2005; Mailloux et. al., 2011; Mailloux et. al., 2018; Smith Roley et. al., 2001a; Schaaf and Mailloux, 2015). Each sensory integration domain was defined, the role of the domain in function was described and observations of occupational performance difficulties within the domain were described. See 6.2.3.2 for a description of these domains.

5.2.4.3 Procedure for the breakdown of the activity into measurable actions

Each activity consists of a sequence of tasks that need to be completed. These tasks were broken down into the specific actions required to complete these tasks. Each action was further analysed and the underlying sensory integration domain that challenged the action was described.

The description of what each activity accomplish is described in 6.2.3.1.

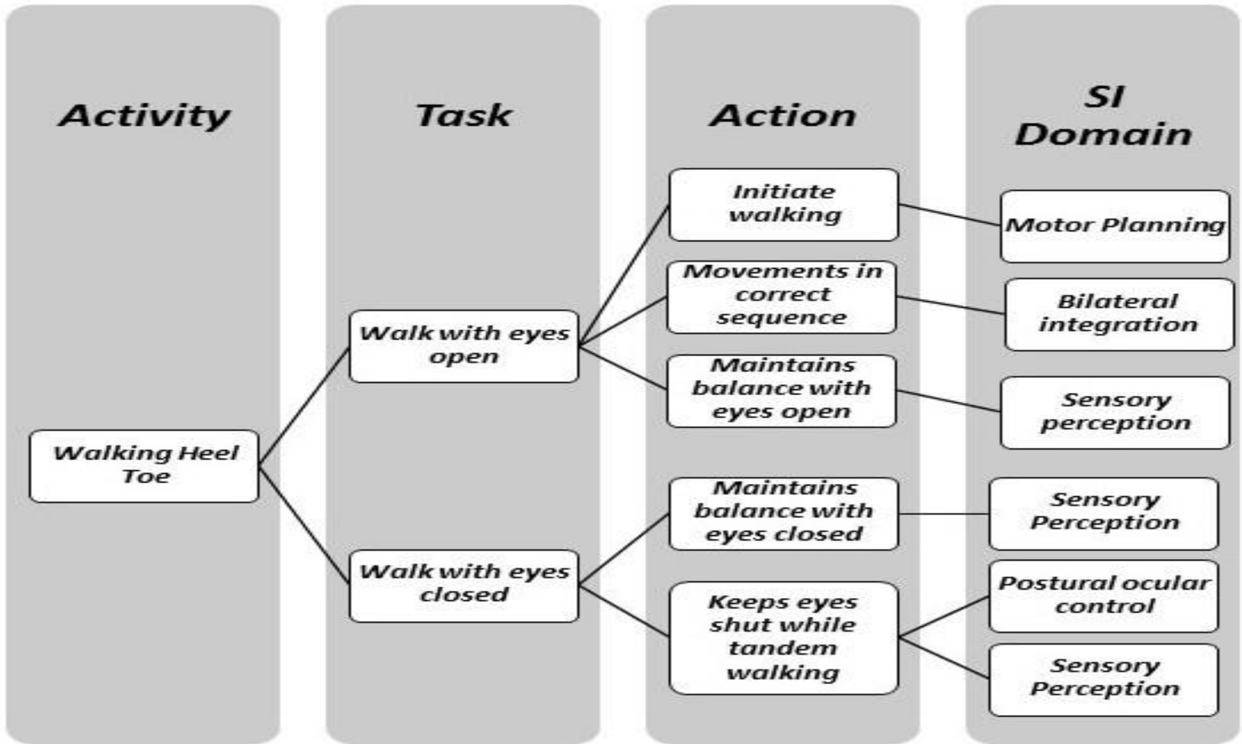


Figure 5.1: Visual representation of the activity analysis process used to develop the administration and scoring format for activities.

5.2.4.4. Method to develop the administration and scoring procedure

Kielhofner (2006a) stated that the actual mechanism used to gather information should be explained in detail in the administration and scoring of the instrument. Fawcett (2013) agreed that a standard, unchanging administration procedure was essential to ensure the results are valid and reliable, resulting in a consistent scoring procedure, despite being administered by different occupational therapists and over time. The following criteria were used in developing the administration and scoring procedures:

- Administration format: A statement of the purpose and intended use of each activity was described for the administration procedure.
    - Activities were identified in Objective 2 as the mechanism to gather information on sensory integration difficulties. The activity analysis in 5.2.3.3 was used to break each activity down into a sequence of tasks, the actions needed for completion of the tasks and the underlying sensory domain identified for each action. These observable actions were scored according to a rating scale.

- The format specifications were described; this included the structuring of the activity for administration, the materials and equipment needed for execution of the activity and the time limit for administration of the activity.
- Specific instructions were developed for the administration of each of the activities.
- The format for a response booklet for the child and examiner's record keeping was developed and described.

- Scoring format: The format was based on the observable actions within an activity, and rated according to a 4-point Likert scale.
  - The scoring format used the Likert scale to measure the child's ability to process and integrate sensory input from the environment. The score was based on the amount of support needed to initiate, participate and accomplish a task, the accuracy of movements and task completion, coordinated movements, and the rhythm and fluency of their movements.
  - The procedure to describe the interpretation of final total scores, e.g. if cut scores will be used and if the screening instrument will be norm referenced or criterion referenced.
  - Specific administrator scoring qualifications and guidelines for the training and monitoring of administrators were developed.

By considering the criteria above in the development of the format and the scoring system, the researcher strived to ensure a culturally appropriate instrument that would be easy to use by newly qualified occupational therapists.

5.2.5 Objective 4: To compile an administration manual and clinician training programme to guide administration and scoring of the screening instrument

5.2.5.1 Considerations in the planning and development of the administration manual

The American Educational Research Association et. al. (2014) provided standards on the test specifications and documents needed to support test administration and scoring.

- Within the first part of the administration manual the following test specifications were described, e.g. the purpose of the screening instrument, intended population, definitions of the construct measured, the item formats and the ordering of the items and sections. Since scoring is based on the observation of the child, the screening instrument should be administered on an individual basis.

- The second part of the administration manual considered the requirements for test administrators to administer the screening instrument, e.g. administrator needs to be an occupational therapist, the administrator need to complete training on the use of the screening instrument before administrating it (American Educational Research Association et. al., 2014).
- The third part of the manual focused on the administration of the activities. Detailed instructions were developed to guide the test administrator to administer the screening instrument in a standardised way. Overall instructions were provided for the administration of the activities, the test kit and the equipment needed, the testing environment and the documentation needed for the administration of the instrument. Documents such as the background information sheet with the child's name, age, date of birth and home language, as well as the activity-scoring sheet and the worksheets needed for each activity were included.
- Detailed instructions on how to administer each activity was developed and included the length of the activity, the specific materials to be used, step-by-step verbal instructions to the children, practice opportunities for the specific activity, scoring procedures and scoring sheets.
- The scoring process is based on step-by-step observations of the child's behaviour and performance in each activity, as identified through the activity analysis. As the screening instrument is aimed for use by occupational therapists with only basic knowledge of sensory integration, the burden on the examiner is minimised by providing specific observations to aid with scoring. Scoring sheets for each of the activities were developed to simplify the scoring process. Examples of the scoring sheets for each activity were included in the manual (Appendix F).
- Scoring instructions during administration of the screening instrument were developed.
- See Appendix F for the initial version of the manual. The manual was refined as the screening instrument was further developed.

5.2.5.2 Considerations in the planning and developing of a training programme for administrators

The American Educational Research Association et. al. (2014) proposed that if an assessment is a performance measure dependent on human judgement, a plan should be in place to ensure that there is no bias in scorer judgement. Scoring specifications, such as the scorer qualification, training of scorers, monitoring of scores and addressing discrepancies in scoring, need to be addressed (American Educational Research Association et. al., 2014). To address these specifications, a comprehensive training programme was developed to guide the clinicians in the use of the screening instrument.

Firstly, topics and related learning objectives for the training programme were developed to ensure that clinicians knew exactly what information was important and to determine if clinicians mastered the specific skill. The training programme consisted of the following topics and learning objectives (cf. Appendix G):

- Background on the development of the screening instrument.
- Administration and scoring of the screening instrument.
- Ethical testing practices.
- Specifications on the format of presentation of the training for the administration of the screening instrument and the measurement of competence in administrating and scoring the screening instrument.

5.2.6 Summary of the methodology for Phase one

The sensory integration screening instrument was developed using the Delphi process for item development. The items were further developed through activity analysis to identify sensory integration demands of the six chosen activities. Specific guidelines were set for the various test specifications for administration and scoring. An administration manual and training programme was developed for the training of administrators in the use of the sensory integration screening instrument. Following the development of the screening instrument in Phase one of the study, the screening instrument was named the South African Sensory Integration Screening Instrument (SASISI).

5.3 METHODOLOGY OF PHASE TWO

The aim of Phase two was to pilot test, refine and determine internal construct validity and clinical utility of the sensory integration screening instrument on children 5 years 0 months to 6 years 11 months of age in low socio-economic environments. The objectives for Phase two included:

- To pilot test the screening instrument with children growing up within low socio-economic environments.
- To establish internal construct validity of the sensory integration screening instrument.
- To establish clinical utility of the newly developed sensory integration instrument, e.g. appropriateness for use and difficulties with administration and scoring.

5.3.1 Study Design

A mixed method explanatory sequential design was used during Phase two of the study. Within this phase, the explanatory sequential design was used to gather data in two interactive phases. The first data collection phase consisted of the use of quantitative data to validate the screening instrument on 200 children from low socio-economic environments. Data analysis included the Rasch model to determine internal construct validity. The second phase of data collection consisted of a qualitative data collection process, through the interviewing of research assistants regarding the clinical utility of the newly developed tool. The qualitative results provided more in-depth information on the administration and scoring of the screening instrument and assisted in the refinement of the screening instrument for the quantitative data collection in Phase three.

5.3.2 Objective 1: To pilot test the screening instrument within low socio-economic environments.

According to Kielhofner (2006a), a pilot study assists in determining difficulties in terms of administration, as well as difficulty of items, prior to using the instrument. A pilot test was done to test the use of equipment, use of instructions and language, and ease of administration and scoring of the instrument. The instrument was piloted on a convenient sample of three typical children from high socio-economic areas and low socio-economic areas. This was done to determine item difficulty. The expectation was that children from high socio-economic areas would perform better than would those from low socio-economic areas. The two groups were selected to ensure that administration was applicable to children from low socio-economic environments.

5.3.2.1. Data collection procedures and tools for pilot testing

A custom-designed data collection checklist with specific observations to determine any difficulties with administration and scoring of the sensory integration screening instrument was used (Appendix H). The observations included clarity of instructions, practicality and feasibility of the procedures, ease of scoring, difficulty of the items, language of instruction, the familiarity of equipment and materials to the child. The children were assessed individually using the screening instrument, which was administered by the researcher and scored according to the instructions in the administration manual. The researcher made notes on the observation checklist regarding the difficulties children experienced with the activities and the interaction with the equipment, as well as difficulties the researcher experienced in scoring the activities (Appendix H).

5.3.2.2. Data analysis for pilot testing

Following the assessment of all six children, the researcher combined the scores of the sample on all the items as well as the notes made during the pilot study for each child into one document for ease of analysis. The notes were used to formulate recommendations for changes that needed to be made for administration and scoring in the sensory integration screening instrument.

5.3.3 Objective 2: To establish internal construct validity of the sensory integration screening instrument

5.3.3.1 Population and sample for internal construct validity

The population for the field-testing of the screening instrument included typically developing children, 5 years 0 months to 6 years 11 months of age from low-socio economic environments. In South Africa, children from the age of 5 years attend grade R (reception year), which is similar to kindergarten in the USA or the foundation year in the UK; formal schooling starts from 6 years of age in grade 1, which is similar to first grade in the USA or year 1 in the UK.

A convenient sample of schools were chosen from Gauteng and the Dr. Kenneth Kaunda District in the North-West Province, as these areas were within a 150-km radius from the university for ease of access and availability of research assistants and for the researcher. A purposive sampling method was used to choose the children who adhered to the inclusion criteria for the study.

Yamane (1967) calculation for sample size was used to determine the sample size for the construct validity using the following formula:

$$n = \frac{N}{1+N(e)^2}$$

A 95% confidence level was assumed; n was the sample size, N the population size, and e the level of precision. N = the population size and included the number of children from grade R and grade 1, as reported by the Department of Basic Education (2015). The population included 171 867 children and a level of 0.07 was set as the level of precision.

$$n = \frac{N}{1+N(e)^2} = \frac{171\,867}{1+\,171\,867\;(0.07)^2}$$ = 203 children were needed to be assessed

5.3.3.1.1 Selection of the school sample

A list of non-paying schools for 2013 was obtained from the Department of Basic Education website (Department of Basic Education, 2013) to identify quintile one schools for inclusion in the study.

> Pandor (2006: 27) defined the national quintile groupings for public schools as *"One of five groups into which all South African public ordinary schools are placed, and where the grouping is according to the poverty of the community around the school. Quintile one, is the poorest quintile, quintile two is the second-poorest quintile, and so on. Each national quintile encompasses one-fifth of the learners enrolled in public ordinary schools. In this policy, 'national quintile' means 'national quintile for public schools.'*'

Schools from quintile one schools were selected, as these are non-school fee-paying schools within low socio-economic areas. By including these schools, the researcher guaranteed the children lived in low socio-economic areas. Quintile one schools within Gauteng and the Dr. Kenneth Kaunda district in the North-West province with grade R and grade 1 classes were identified, as these grades include children from 5 years to 6 years 11 months. From the schools identified, two were selected from Gauteng Province and one from the Dr. Kenneth Kaunda District in North-West Province. In Gauteng Province, one school was chosen from Soweto and one from Alexandra for representation of the urban areas within Gauteng. In North-West Province, the school was chosen from Ikageng in Potchefstroom, for representation of the rural area. These schools were chosen as they were within driving distance from the University of the Witwatersrand and therefore easy to access.

5.3.3.1.2 Selection of child sample

Children within the three chosen schools were identified according to specific inclusion and exclusion criteria.

<u>Inclusion criteria:</u>

- Children 5 years 0 months to 6 years 11 months old from the selected schools within in low socio-economic environments in Gauteng and North-West Province.
- This age group was chosen for the following reasons:
  - According to a pilot study conducted at a hospital in North West Province, 70.3 % of the children referred for services where between 5 years and 6 years 11 months (Van der Linde, 2009).
  - This is traditionally the age group where children attend school for the first time in South Africa and identified as having difficulties and thus referred for occupational therapy intervention (Van der Linde and Olivier, 2010).
  - The age range falls within the range for using the SIPT test, the gold standard test, that is within 4.0 years and 8.11 years of age (Ayres, 2004).
  - Children living within low socio-economic areas who attend a non-paying school, have a care-giver that receives a child support grant from the department of social development, a child that receives financial assistance from the school, government, a charity or an NGO, or a child that receives daily meals from a food scheme. These criteria reflect the services or organisations that provide assistance to children living in low socio-economic areas to alleviate the effect of poverty (Delany et. al., 2016).
  - Children with consent from parents or guardians for participation in the study, consent from the parent for the child to be video-recorded, as well as assent from the participating child.

<u>Exclusion criteria:</u>

- Children with obvious learning difficulties, e.g. poor academic abilities, poor attention and memory, language difficulties and social and emotional difficulties, as described by Nel and Grosser (2016).
- Children diagnosed with Autism, ADHD, CP, neurological deficits, cognitive deficits, hearing and visual difficulties and epilepsy, as the literature indicated these children experience difficulties with sensory integration (Smith Roley et. al., 2001b; Schaaf and Smith Roley, 2006).
- Children who received occupational therapy input on previous occasions, as this may indicate a learning difficulty or any of the above diagnoses.

5.3.3.1.3 Selection of research assistants

A purposive sample was used, as Etikan et. al. (2016) stated that purposive sampling is an appropriate technique to use when the researcher deliberately wants to include participants that are well versed in the topic being explored. A call for research assistants was sent out through the Occupational Therapy Association of South Africa (OTASA). The requirements for a research assistant included being a qualified occupational therapist working in the public, private or educational setting, having experience in paediatric occupational therapy and having basic knowledge of sensory integration (Appendix S). Interest from possible participants was positive, but due to high workload, location and financial constraints only four occupational therapists could assist as research assistants. The four research assistants went through the online training programme, as well as a face-to-face group session, to practice the administration of the test. The face-to-face session ensured that misunderstandings in scoring were discussed and eliminated.

5.3.3.2. Data collection procedure and tools

The testing for internal construct validity was done in the three low socio-economic areas within Soweto, Alexandra and Ikageng, Potchefstroom. These areas were chosen due to ease of access. Firstly, permission was obtained from the Department of Education within Gauteng (Appendix J) and the Department of Education in North-West Province (Appendix K) to approach schools for participation. The chosen schools were contacted, and the headmaster of each was approached for their consent to participate within the study. The researcher visited the school in person to explain the process and the expectations to the headmaster and to obtain the written consent. The headmasters of each school received an information letter and permission letter (Appendix L) and gave written permission for the children in their school to be approached for participation in the study (Appendix M).

The headmaster in each school assisted in identifying children for participation in the study by sending out the information letter and consent letter (Appendix N), together with a brief note from the school to the parents; this note included an explanation about the research process and the consent required. Headmasters informed parents during parent meetings held at the school of the research. This process assisted in ensuring that parents understood, in their own language, the goal of the research and the expectations. Parents needed to give consent for their children to participate in the study and to be videoed during the assessment sessions. Following the above process, the final sample for the field-testing consisted of 200 children, of whom 99 children were from Soweto, 44 from Alexandra and 57 from Ikageng in Potchefstroom.

Only 200 children were eligible for inclusion from the three selected schools as the other children were older than 7 years of age.

Data during this phase were collected via the following tools and instruments:

- Background information sheet (Appendix P). This sheet recorded information on the code used to identify the child, an indication of the child's assent to participate, the child's date of birth, gender, home language, grade, date of assessment and the assessments completed. The researcher and research assistants completed this form during the data collection process.
- Adapted HESSI questionnaire (Appendix Q). This form was adapted from the Indicators of Economic Status and Social Capital in South African Townships by Khomo and Barbarin (1997). The original questionnaire determined the level of poverty within a family, but for this study, it was not necessary, as this was included in the inclusion criteria. The researcher used it to collect data on the family's home environment and resources available in the community.
- Teacher's questionnaire (Appendix R). This questionnaire was completed by the class teacher to determine the type of difficulties the child was experiencing in class, compared to the typical behaviour of other children in class. The information from this questionnaire provided valuable information on the sample's performance in class.
- The South African Sensory Integration Screening Instrument (SASISI) (Appendix F). This was the newly developed instrument developed during Phase one and administered by the researcher and the four occupational therapy research assistants.

The children were assessed within the school setting by the research assistants. This course of action was decided on because the families did not have the means or funds to travel to an occupational therapy clinic or the university. The school provided the researcher with a room for use during the assessment period and participants were taken out of class with permission from the teacher and tested individually on the screening instrument. This process was followed to ensure an optimal testing situation.

The data collection were done in the mornings during formal school hours, as children were not able to stay after school due to transport difficulties. Children were not assessed during break times to ensure they received the meal provided by the school and to provide time for play and rest.

- The teachers within all three schools were briefed regarding the goal of the research project and the steps of the testing process. The class teachers assisted in identifying the children, who were taken from the classroom for assessment, and completed the teacher questionnaire for each of these children.
- On arrival in the testing area, the children were introduced to the activities, asked for assent to participate in the study (Appendix O) and asked to complete the six activities from the screening instrument as administered by the research assistant. Instructions were given verbally or by demonstration, depending on the level of understanding of the participant, prior to the start of each activity.
- Due to the large numbers of children that needed to be tested, having only one research assistant available in Gauteng and a brief period available for testing, the researcher had to assist in the administration of the screening instrument. To prevent bias, the researcher administrated the screening instrument, but it was videotaped in order for the scoring to be checked by one of the research assistants.
- On completion of the screening assessment, the participant returned to the classroom.

The data collected from the questionnaires and assessment of the children were prepared for data analysis as follows:

- **Demographic information:** The information was gathered onto an Excel spreadsheet, and included gender, age group, school, language and therapist doing the assessment.
- **Questionnaires:** Raw data from the HESSI questionnaire and the teacher questionnaire were captured onto an Excel spreadsheet for descriptive analysis.
- **SASISI scores:** Data from the screening instrument score sheets were captured onto an Excel spreadsheet for analysis. Each observation on the sensory integration screening instrument was captured onto the Excel spreadsheet as an item descriptor and allocated an item number. The items were grouped under the specific domain, e.g. sensory perception. The score for each item descriptor, between one and four, was captured for each item on the Excel spreadsheet for each child. Data from the population of n=200 children were used for analysis. Table 5.1 provides a visual representation of how data were captured for the SASISI.

Items were numbered separately for each domain, e.g. sensory perception (66 items), postural ocular control (55 items), bilateral integration and sequencing (38 items), praxis (70 items), handling of objects (32 items), visual spatial (46 items), sensory modulation (8 items), organisation of space and environment (6 items) and organisation of self and behaviour (11 items).

Table 5.1: Visual representation of the data capturing Excel spreadsheet

sub domain	Sensory perception						
	Item number						
Item number	1	2	3	4	5	6	7
	Item Description						
CHILD ID	Determine where garment is on his/her body through using touch	Knowledge of where body/body parts are in space.	Postural movements and changes during the activity effective	Balance and equilibrium reactions while taking garment off	Balance and equilibrium while putting the shirt on	Knowledge of where body/body parts are in space.	Postural movements and changes during the activity effective
	Score captured (1-4)						
1	4	3	3	3	3	3	3
2	4	4	4	4	4	4	4
3	4	4	4	4	4	4	4
4	4	4	4	4	4	4	4
5	3	3	3	3	4	4	4

A new Excel spreadsheet was created separately for each domain and prepared for Rasch analysis, according to the requirements of the RUMM2030 software (Andrich et. al., 2010). The Excel spreadsheet was set up as follows:

- The columns were resised to "1" and the sheet was saved as a prn file format for use in the RUMM2030 software.
- The first column included the identifying number of the child from 1 to 200.
- The next columns represented the item numbers, but no column names were given. The scores for the item numbers within the specific domain analysed were copied to the Excel spreadsheet, making sure the scores for each child were in the row that represented the number for the specific child.
- The row for each child was checked to ensure no other information was copied to a row and only a score of 1 to 4 was allocated to a block.

5.3.3.3 Data analysis for internal construct validity

Data analysis were done as follows:

- **Environmental context:** A review of the literature was used to describe the context of Soweto, Alexandra and Ikageng. This was done to provide the reader with context on the low socio-economic environment where the research was conducted.

- **Participant context:** Demographic information from the participants were collected from the consent forms and the HESSI questionnaire. Data analysis were done using basic descriptive analysis, using the statistical features of Excel and reported as means and percentages.
- **Participant school performance:** Raw data were from the teacher questionnaire were analysed using the statistical functions of Excel for descriptive analysis. The results were reported as means and percentages.
- **SASISI scores:** Data analysis of the SASISI scores were done using RUMM2030 software to determine the internal construct validity as discussed under Objective 2 of Phase two. The psychometric analysis of this instrument was done through the Rasch measurement model, which is a simple logistic model with specific criteria that needs to be met in order for the data to fit the model (Petrillo et. al., 2015). Analysis was done through the use of the RUMM2030 programme (Andrich et. al., 2010). Different software, such as RUMM2030, Winsteps or Quest, are available for analysis of the data, yet Linacre (2015) suggested that RUMM2030 and Winsteps are the most frequently used. It was suggested that although both RUMM2030 and Winsteps have similar analysis, RUMM2030 has greater perfection for following the statistical model; it is interactive and easier to use and seen more frequently in Social Science research (Linacre, 2015; Sick, 2009). It was also the software of choice, as researchers at the University of the Witwatersrand, where the study was registered, have been trained in this software and their expertise was used.

  A step-by-step process was followed for the Rasch analysis, where each sensory integration domain of the screening instrument was analysed to determine the fit to the Rasch model requirements for ordered thresholds, item and person fit, local independence, differential item functioning (DIF), reliability and uni-dimensionality. These requirements are explained in the following sections.

  - **Threshold ordering:** Threshold ordering investigates if the category structure, the scale of the instrument, is consistently measuring the latent variables (Tennant and Conaghan, 2007). Ordered response data are when a response can fall within any of the response categories, whereas the threshold is the point where the response has a 50% chance to fall in two adjacent categories (Hendriks et. al., 2012). Threshold ordering determines the ability of the scores or categories to discriminate between responses. Disordered categories do not discriminate consistently between responses and collapsing the categories may correct them. Different combinations may be trialled, which may represent data more accurately (De Klerk et. al., 2013).

Categories for items were collapsed and different combinations were tried, but if further analysis did not indicate improved thresholds, some items were deleted until all categories were appropriately ordered.

- **Item and person fit:** Retief et. al. (2013: 132) describe item fit as "the expected and observed responses of individuals and groups to each of the items." According to Mills et. al. (2010), the Rasch model assumes there is a link between the person's ability to react to or perform the item and the item's difficulty. The Rasch model further transforms raw scores for items, as well as persons, into measures known as locations or logits. Logits allow measurement, using common units on a common scale, to compare between items and respondents (Hendriks et. al., 2012). This ensures both item and person fit are measured individually, but on the same continuum, and allows for generalisation of results across the sample (Curtin et. al., 2016; Hendriks et. al., 2012). Following the threshold ordering, further analysis investigated the person fit to the model. A person that misfits can be deleted in an attempt to improve internal construct validity (Tennant and Conaghan, 2007). Person fit was investigated and showed the extent to which the person's ability differs from the expectations of the Rasch model (Bond and Fox, 2015). The model calculates the person's performance on these items to determine if there were any inconsistent responses to the items, which is when a person scores the same value for all items in a test. The analysis attempted to determine if Item and person fit statistics had standard deviation values of 1.0 with a value of less than 1.4 as acceptable (Curtin et. al., 2016; Velozo et. al., 2006). Analysis of item fit statistics was done for each domain of the sensory integration screening instrument to determine where the domain fell within the set range. Item fit statistics can be measured as a mean item fit residual score, where logits must fall within a range from ± 2.5 for fit with model requirements. Further information on item fit statistics were provided by the Chi-square value, as well as item characteristic curves (ICC) (Curtin et. al., 2016). During analysis, items were deleted to reach a Chi-square value of > 0.05 to demonstrate the fit of the data to the Rasch model. The assumption is that there should not be a significant difference between the expected values or the expectations of the model and the changes made during analysis aimed to reach values of 0.05 or higher.
- **Local independence:** This refers to the ability of the item to measure a specific aspect of the latent trait without the influence of other items. Local dependency occurs when one item influences the selection of following items (Curtin et. al., 2016). The analysis of local independence investigated inter-item correlations and correlations between items. Residual correlations analysis was done to determine which items fit together. These items were grouped into subtests to determine local dependency.

Residual correlation scores less than 0.30 implied there was no local dependency, but inter-item correlations and correlations of > 0.30 showed strong local dependency. Items with local dependence were reviewed and deleted.

- **Differential item functioning:** Differential item functioning (DIF) determines whether subgroups within the sample respond different to an item and may have advantages or disadvantages in comparison to other subgroups. DIF measures the item bias for gender, age and culture (Retief et. al., 2013). Analysis of gender bias was done. Differences between male and female can be determined, e.g. if an item is more favourable to males than females. In such cases, items can be split in such a way that males will have a set of male-related items and women a set of women-related items.
- **Reliability**: Reliability is a vital component of the psychometric analysis of data as it indicate if the instrument will obtain similar information at separate times and within different samples. The Rasch measurement model investigates internal consistency of the instrument by determining the person's separation index, similar to Cronbach's alpha (McCreary et. al., 2013; Tennant and Conaghan, 2007) but calculated slightly different. The person separation index (PSI) is calculated from the estimated person-locations, which are non-linear transformations of the raw scores. Cronbach's alpha is the standard deviation of the raw scores and a value of above 0.85 indicates good internal consistency of the instrument (Velozo et. al., 2006). Throughout the data analysis process in RUMM2030, an attempt was made not to only adhere to the Rasch requirements, but to obtain a PSI value of above 0.85. Attempts to improve the PSI included the threshold ordering or deletion of items.
- **Uni-dimensionality:** Uni-dimensionality is another indication of the fit of data to the Rasch model (Tennant and Conaghan, 2007). Uni-dimensionality assumes the items measure only a specific latent trait (construct), and that item raw scores can be summed together to provide a total score (Adedoyin and Adedoyin, 2013; Retief et. al., 2013). Uni-dimensionality is determined through an equating t-test, where differences between each person is reported as a percentage of a test that fell outside the range of +/- 1.96 and should not be more than 5% (Tennant and Conaghan, 2007). An equating t-test was done to determine uni-dimensionality. This was followed by determining confidence intervals for Binomial tests of proportions to determine if a test fell outside the range of +/- 1.96, and to determine if scores could be summed.

The requirements for the Rasch model were analysed in a step-by-step way and changes were made to items, e.g. deleting items to improve fit to the model. The results for each Rasch model requirement will be discussed under the domains of sensory integration in the screening instrument in Chapter 6.

5.3.4 Objective 3: To establish clinical utility of the screening instrument

The undertaking to establish the clinical utility of the sensory integration screening instrument was to ensure it was appropriate for use within low socio-economic areas. The researcher wanted to determine the appropriateness and usefulness of the SASISI to establish clinical utility of the instrument.

5.3.4.1 Population and sample to establish clinical utility

The participants for this objective were the four research assistants who administered the test to the children in the field test (Objective 2 above).

5.3.4.2 Data collection procedures and tools to establish clinical utility

Individual interviews were done with the participants, and the researcher developed an interview guide with specific questions on the appropriateness and usefulness of the assessment activities. The participants were asked to comment on their experience of the administration and scoring process and the guidelines available to guide them (Appendix T). The researcher made appointments for specific times to conduct the interviews at the participants' workplace to minimise the influence on their time away from work. The interviews were conducted in an office at the participants workplace to minimise disruptions and to provide the participant with a comfortable environment to engage with the researcher. Participants were informed about the aim of the interviews and that they would be audio-recorded for data analysis purposes, before the researcher obtained consent for participation (Appendix T). During the interview, the researcher collected data through audio recordings and by making notes of the participants' feedback during the interviews.

5.3.4.3 Data analysis of interviews to establish clinical utility

A six step analysis described by Creswell (2009), derived from the eight step coding process by Tesch, was followed.

- Step 1: The researcher compiled the field notes taken during the interview into one Word document. A table was compiled with four columns and a separate row for each question asked during the interview. The answers of each participant were collected in a separate column according to the question. The audio recordings were used to confirm the correctness of the field notes and to determine if the researcher missed any information.

- Step 2 involved the reading of the participants' answers to get a general idea of their feedback.
- Step 3 included the analysis and coding of the data. Initially MaxQDA software was used to investigate themes, but due to the specific questions that were asked in the interviews, coding was found to yield little results. The researcher decided to use content analysis to determine similar or different responses to the specific questions asked.
- Step 4 involved the analysis and description of the participants and their background information, namely age, highest level of training, years of experience in occupational therapy, and years of experience in sensory integration were gathered from participants' feedback. The background information was analysed using Excel's statistical functions providing descriptive statistics, such as means and percentages.
- Step 5 involved the identification and description of the codes, categories and sub-categories and final themes.
- Step 6 involved the verification of data analysis. The same trustworthiness aspects were used as discussed in Phase one, Objective one, and findings by a colleague to establish trustworthiness and verification of the data using double coding or peer review of the data.

5.3.5 Summary of the methodology for Phase two

Objective 1 of this phase set out the methodology to pilot test the screening instrument within low socio-economic environments. Detailed information is given on the sample, data collection and data analysis processes that were followed.

Objective 2 of Phase two involved the field-testing of the screening instrument to establish the internal construct validity of the screening instrument. The methodology in selecting the three samples used in this objective, as well as the data collection procedure, preparation for data analysis, the data analysis process using the Rasch model and the RUMM2030 analysis programme, were described in detail.

Objective 3 of Phase two described the methodology for establishing the clinical utility of the screening instrument. A qualitative study design was used and the process of gathering data from the occupational therapy research assistants, as well as the process of content analysis of the data, were described.

The results for this phase are reported in Chapter 6. The results for this phase guided the methodology for Phase three to establish the psychometric properties of the newly developed sensory integration screening instrument.

5.4 METHODOLOGY OF PHASE THREE

The aim of this phase was to establish selected psychometric properties of the sensory integration screening instrument. The objectives to reach this aim were:

1. To determine the content validity of the sensory integration screening instrument.
2. To establish concurrent validity by comparing the sensory integration screening instrument against the gold standard, the SIPT measurement.
3. To establish sensitivity and specificity of the sensory integration screening instrument.

5.4.1 Study Design

A quantitative cross-sectional design was used for this phase of the study. This design was used as data were gathered in one point of time of the specific population. Kielhofner (2006b) stated this type of research design does not require prolonged times of execution, is less expensive and provides a snapshot of the population. It is often the design used for investigation of psychometric properties.

5.4.2 Objective 1: To determine the content validity of the sensory integration screening instrument

As part of the validation process of the sensory integration screening instrument, it is important to determine the content validity of the instrument. According to Polit and Beck (2006), content validity provides information on the agreement by experts on the appropriateness of the description of the underlying construct (Polit and Beck, 2006).

5.4.2.1 Population and sample selection to determine content validity

Content validity testing involved a panel of experts in sensory integration to judge the appropriateness of the sensory aspect measured for each step of an activity, within the SASISI. Lynn (1986) proposed a minimum of three, and a maximum of ten experts to rate the items. Experts in sensory integration were chosen according to specific criteria. No children were included in this objective, as appropriateness of the sensory aspect based on sensory integration theory was measured.

5.4.2.1.1 Inclusion criteria for panel of experts for content validity

- Active members of SAISI, who completed their full training in assessment and intervention in sensory integration.
- The expert has worked in occupational therapy using sensory integration as a frame of reference for a minimum of at least 3 years.
- Currently practicing as occupational therapist in the field of paediatric occupational therapy.
- Familiar with the administration of the SIPT and other standardised assessment tools.
- Involved in the training of students in the assessment of sensory integration.

5.4.2.2 Data collection procedure and tool to determine the content validity

A content validity questionnaire was compiled on an Excel spreadsheet, with the first column containing the step of the activity measured, and the second column the sensory item measured for that specific activity. Experts were asked to rate the appropriateness or relevance of each sensory item measured to the sensory integration construct, by allocating a score between one and four to the step. Davis (1992) proposed using a four-point scale to determine the relevance of the item to measuring the underlying construct. The scores in the content validity questionnaire asked raters to use the Likert scale format of 1 = not appropriate/relevant, 2 = very little relation/little relevance, 3 = some appropriateness/relevance, 4 = very relevant and appropriate (refer to Appendix U). The content validity questionnaire was emailed to the six experts in sensory integration with a request to rate the sensory items for relevance to the underlying sensory integration construct. Experts were asked to mail the Excel spreadsheet to the researcher on completion. Participation in the content validity process were taken as consent for participation.

5.4.2.3 Data analysis to determine the content validity

Polit and Beck (2006) proposed that not only should content validity be determined for each item, but also for the scale as a whole. The Item-Level Content Validity Index, as well as the Scale-level Content Validity Index was determined for the sensory integration screening instrument.

- Firstly, the Item-level CVI was calculated by adding the number of experts that rated an item as a three (some relevance), or a four (very relevant) on the four-point rating scale, divided by the number of experts. For example, if all six experts score Quality of Control of body movements a four, the number of experts equals 6, divided by the total number of experts, (which is also 6), giving a score of 1, or an item-level CVI of 1.00.

- An item-level CVI score was determined for each individual item within an activity, the scores were totalled for the activity and an average total score was worked out for each activity.
- The Mean Item-level CVI was firstly worked out by adding the average score for each activity and dividing it by the seven activities to get a mean score. A Scale-level CVI, average method is the same score as the Mean Item-level CVI.
- A Scale-level CVI, universal agreement method (S-CVI/UA), was worked out by the inclusion of only items with a total agreement by raters, e.g. an item score of 1.00. These item scores were summed and divided by the total number of items. The scale-level CVI is thus more stringent than the item-level CVI because only total agreement or item scores of 1.00 are included in the calculation.

5.4.3. Objective 2: To establish concurrent validity by comparing the sensory integration screening instrument against the gold standard, the SIPT

5.4.3.1 Population and sample selection to determine concurrent validity

The population for concurrent validity included children with suspected sensory integration difficulties, 5 years 0 months to 6 years 11 months of age, from low-socio economic environments in Gauteng and the Dr. Kenneth Kaunda District in North-West Province. Israel (1992) proposed one method to determine the sample size for a study could be to base it on the sample size of another study determining a similar goal. The sample size to determine the concurrent validity was based on evidence from previous research where the sensory integration tests were compared to the Kaufman Assessment Battery for children (n = 35 learning-disabled children), the Bruininks-Oseretsky Tests of Motor Proficiency (n = 49 children with learning disabilities), and the Bender-Gestalt Test (n = 26 children with suspected sensory integration difficulties). A sample size of n =36 was set to determine the concurrent validity between the SASISI and the SIPT.

5.4.3.1.1 Selection of sample for objective 2 of phase three

- The same convenient sample of schools as identified in Objective two of Phase two in Gauteng and North-West Province were approached for participation in Phase three.
- A purposive sample of children with suspected sensory integration difficulties, and adhering to the set inclusion criteria, from the above-mentioned schools were identified by grade R and grade one teachers, using a teacher's questionnaire (Appendix R).

- A purposive sample of children was recruited from a paediatric clinic in Gauteng, the University of the Witwatersrand's occupational therapy paediatric clinic, and in North-West Province, the Potchefstroom hospital's occupational therapy paediatric clinic.

  These sites were included as they provide services to children from low socio-economic areas and they fall within the chosen research areas.
- The purposive sample of children as mentioned above were identified using the same inclusion criteria, as well as the same teacher's checklist as used in the school sample.

Inclusion criteria for children

- Children with suspected sensory integration difficulties; this was determined using the teacher's questionnaire (Appendix R). The teacher's questionnaire was based on specific sensory integration difficulties observed in the classroom. A child that received a score of three, indicating they need more assistance than other children of the same age, on more than three questions of the questionnaire may present with sensory integration difficulties.
- Aged 5 years 0 months to 6 years 11 months.
- Children living within low socio-economic areas that attend a non-paying school, have a care-giver who receives a child support grant from the department of social development, a child who receives financial assistance from the school, government, a charity, or an NGO or a child who receives daily meals from a food scheme. These criteria reflect the services or organisations that provide assistance to children living in low socio-economic areas to alleviate the effect of poverty (Delany et. al., 2016).
- Children with consent from parents or guardians for participation in the study, consent from the parent for the child to be video-recorded, as well as assent from the participating child (Appendix N & O).

Exclusion criteria

- Children with neurological difficulties, visual and hearing impairments, Autism, ADHD and epilepsy were excluded.
- Children that received occupational therapy within the last three months (previous therapy input may influence the assessment results).
- Children that already completed a SIPT assessment in the past.

5.4.3.1.2 Selection of occupational therapist research assistants

A call for occupational therapist research assistants to assist with the administration and scoring of the SIPT was sent out through the SAISI office. The requirements for an occupational therapist research assistant included being a qualified occupational therapist working in the public, private or education setting, having experience in paediatric occupational therapy, being qualified in the administration and scoring of the SIPT and residing in Gauteng or North-West Province for ease of travel and access to researcher sites. Five occupational therapists committed to assist with the assessment of the SIPT. The same occupational therapist research assistants who did the sensory integration screening test were again included in the study for the administration of the SASISI.

5.4.3.2 Data collection tools and procedure to determine concurrent validity

Data during Phase three were collected via the following documents or instruments:

- Demographic information was collected by the completion of questionnaires by the caregiver and by the class teacher:
  - *Adapted HESSI questionnaire* (Appendix Q): This form was adapted from the Indicators of Economic Status and Social Capital in South African Townships by Khomo and Barbarin (1997). The original questionnaire aimed to determine the level of poverty within a family, but for this study, this was not necessary as poverty levels were included in the inclusion criteria, instead the researcher wanted to collect data on the family's home environment and resources available in the community.
  - *Teacher's questionnaire (*Appendix R*)*: This questionnaire was completed by the class teacher to determine the type of difficulties the child was experiencing in class compared to the typical behaviour of the class. This questionnaire was used as the referral form used for inclusion in the study.
- Formal measurement was done using the SASISI and the SIPT:
  - *The same four occupational therapy research assistants who were involved in Phase two administered the SASISI*. This instrument consists of six activities with specific sensory integration observations scored on a scale of one to four, with a score of one seen as unable to do and four as able to do independently. These observational scores were assigned to specific sensory integration domains identified through activity and Rasch analysis namely: sensory perception, postural and ocular skills, bilateral integration skills, praxis, handling of objects, visual spatial skills, sensory modulation, organisation of space and environment and organisation of self and behaviour.

- *SIPT:* The SIPT consists of 17 tests that measure sensory discrimination in terms of praxis, perception and sensory motor skills (Ayres, 2004). The administration and scoring of the SIPT is very rigid, with specific guidelines as set out in the SIPT manual (Ayres, 2004). The tests included in the SIPT are Space Visualisation (SV), Figure-Ground Perception (FG), Standing and Walking Balance (SWB), Design Copying (DC), Postural Praxis (PPr), Bilateral Motor Coordination (BMC), Praxis on Verbal Command (PrVC), Constructional Praxis (CPr), Postrotary Nystagmus (PRN), Motor Accuracy (MAC), Sequencing Praxis (SPr), Oral Praxis (OPr), Manual Form Perception (MFP), Kinaesthesia (KIN), Finger Identification, (FI), Graphesthesia (GRA) and Localisation of Tactile Stimuli (LTS) (Ayres, 2004). The SIPT is the gold standard in assessing sensory integration, and the literature shows high reliability and validity scores (Ayres, 2004). Test-retest reliability ranging from 0.48 for the PRN test to 0.93 for the Design Copying test and interrater reliability ranges from 0.94 to 0.99 confirm the reliability of the instrument (Ayres, 2004). Construct validity was confirmed through factor analysis and showed that the instrument accurately identified clinically significant groups. Discriminatory analysis of the 17 tests of children within the US, showed that the instrument could significantly ($p = < .01$) discriminate between typical and dysfunctional children.

5.4.3.3 Data collection procedure to determine concurrent validity

The parents were asked to complete the consent form for participation in the study and the videoing of the child. The HESSI questionnaire was sent home with the child and the parent was asked to complete the questionnaire and send it back to the teacher or the occupational therapists who made the referral. The teacher was asked to complete the teacher questionnaire and to return this questionnaire with the HESSI form to the researcher. This was done in this manner because the parents were unable to go to the school or clinic for a face-to-face meeting due to financial constraints.

The formal assessments were done at the school where the children were referred from, for example, children referred from the schools were assessed at the school and those referred from the occupational therapy paediatric clinic were assessed at the clinic. Children were asked for their assent to participate in the study prior to the start of the assessments.

- The children were assessed on the SASISI by the four occupational therapy research assistants involved in Phase two according to the administration manual for the SASISI.

- The SIPT assessments were completed by five SIPT qualified occupational therapists who were recruited for the third phase of the research. Although the SIPT was designed to involve as little language as possible, it does have some verbal instructions, which are written in English. To administer the SIPT to children who speak an African language, it is important to administer the SIPT in their home language to give them the best opportunity to show their strengths. The decision was therefore made to translate the SIPT English instructions into four of the African languages most frequently spoken in Gauteng and North West Province, namely isiZulu, isiXhosa, Sesotho and Setswana (Statistics South Africa, 2017).
  - Permission was obtained from Western Psychological Services' (WPS) rights and permissions department (license no D.A. - 120413) to translate the SIPT instructions into isiZulu, isiXhosa, Sesotho and Setswana (Appendix V).
  - Bangula Educational Services, a translating company that provides translating and interpretation services in Johannesburg, South Africa (Appendix W), translated the instructions. To ensure instructions were delivered in a standardised way, with the correct pronunciation of the words, an audio recording of the four different languages was made. The researcher recruited isiZulu, isiXhosa, Sesotho and Setswana first language speakers from within the School of Therapeutic Sciences, at the University of the Witwatersrand to assist with the making of the audio files. The instructions were ordered on PowerPoint slides with the English, as well as the African language instructions (Appendix X). The person was asked to read the instructions in their African language, and the voice file was added to the PowerPoint with the written instructions. The English instructions were added so that the administrator knew exactly which part of the instructions they were playing.
  - During the assessment process, these presentations were used to deliver the instructions to the child via an iPad or Smartphone. The PowerPoint presentation was downloaded to the administrator's device and the administrator played the instructions at the correct time and stopped once the instructions were given.

5.4.3.4 Preparation of data for analysis of concurrent validity

- The HESSI and teacher's questionnaire: Responses were captured on Redcap (Research Electronic Data Capture). Study data were managed using REDCap electronic data capturing tools hosted at the University of the Witwatersrand. REDCap is a secure, web-based application designed to support data capture for research studies, providing 1) an intuitive interface for validated data entry, 2) audit trails for tracking data manipulation and export procedures, 3) automated export procedures for seamless data download to common statistical packages, and 4) procedures for importing data from external sources.

The raw data were downloaded in an Excel format from Redcap for descriptive analysis using Excel's statistical function reporting in means and percentages.

- SASISI data analysis: The four research assistants involved in the assessment of the SASISI were responsible for the scoring of the SASISI instruments that they administered. They sent the data to the researcher for capturing on an Excel spreadsheet for data analysis. The researcher checked each assessment for accuracy and discussed the scoring with the research assistant if there were any discrepancies in the scoring; for example, giving a high score for an aspect in one activity but scoring a similar aspect low in another activity. This ensured the research assistants were checked for accurate scoring and determined any difficulties with the scoring system. The scoring system was used as follows:
  - Each item score was captured on an Excel spreadsheet.
  - The item score was added to the scores for the specific sensory integration domain that it measured.
  - All the scores for a sensory integration domain were added to determine the total raw score for the specific domain. The mean raw score for the specific domain was determined by dividing the total raw score by 28, or the number of children. This was done for all the domains.
  - A mean score and standard deviation score was calculated for each domain using the statistical function of Excel. The total score for each child was converted to a Z-score using the following formula: child raw score – mean raw score for domain/standard score for the domain. This was done to enable comparison between the scores of the SASISI and the SIPT scores that were reported in Z-scores.
  - These Z-scores were captured on an Excel spreadsheet for further data analysis.

- SIPT data analysis: The five SIPT trained occupational therapists were responsible for scoring each SIPT test they administered. The completed and scored SIPT test booklets were returned to the researcher for capturing of the scores on the Western Psychological Services (WPS) computer based SIPT scoring system. This system generates a report with the appropriate Z-scores (Services, 1996).
  - The z-scores for five of the SIPT tests, namely design copying, bilateral motor coordination, oral praxis, standing and walking balance and motor accuracy were adjusted for children older than 6 years. These scores were adjusted with 0.50 SD to the negative side. This was done because a study by Van Jaarsveld et. al. (2012), on a population of 775 children in South Africa, indicated that children in the older age bands of the SIPT, 6 years 0 months to 8 years 11 months, scored better on these five SIPT tests than the normative sample.

To ensure the children's actual functioning is recorded for the five tests, the scores need to be adjusted with 0.50 SD to the negative side.

- The final z-scores were captured on an Excel spreadsheet for comparison with the SASISI scores.

5.4.3.5 Data analysis to determine concurrent validity

All the data from the demographic questionnaires, SASISI and the SIPT instruments were captured on a single Excel spreadsheet for further analysis using the relevant statistical software.

5.4.3.5.1 Analysis of demographic information

The data from the questionnaires were analysed in Excel using descriptive analysis. Demographic information on gender and age distributions, cultural background and language distribution were analysed in terms of means and percentages. The HESSI questionnaire was analysed in the percentage of family and social structure and access to housing and neighbourhood facilities, and the difference between the two samples. The teacher's question was analysed by first determining the number of children scoring a specific number on the teacher's questionnaire. The percentage of children scoring within a specific score category was determined to show which of the score categories had the highest percentage of children within the sample. The researcher could determine which functional areas, for example attention levels or following instructions, had the highest percentage of children scoring below a score of four. A score of four indicates a child functions on the same level as other children of the same age, but a score of three or less indicates a child has difficulties in the specific functional area.

5.4.3.5.2 Analysis of descriptive SASISI data

The SASISI data were analysed using descriptive data analysis. The descriptive data were analysed and reported on, then used for the concurrent validity analysis.

- All scores for the SASISI were converted to Z-scores as explained under data capturing. This was done to ensure that comparisons could be made with the SIPT measurement that reports final scores in mean Z-scores.
- Statistica™ version 11 software was used for non-parametric descriptive data analysis to determine the mean score for each domain of the SASISI for this specific sample (StatSoft, 2012). The descriptive analysis was used to determine mean scores, ± 95% confidence intervals, minimum and maximum scores and the standard deviation for each domain.

5.4.3.5.3 Analysis of descriptive SIPT data

The SIPT data were analysed using descriptive data analysis. The descriptive data were analysed and reported on, then used for the concurrent validity analysis. Non-parametric data analysis were used, as the sample was not normally distributed.

- Statistica™ version 11 software was used for non-parametric descriptive data analysis to determine the mean score, 95% confidence interval, minimum and maximum scores and the standard deviation for each SIPT subtest (StatSoft, 2012).
- The percentage of children scoring below -1SD was calculated in Excel to determine the percentage of children who had trouble in the SIPT tests. The SIPT manual indicates that a score below -1SD indicates a difficulty (Ayres, 2004).

5.4.3.5.4 Analysis to determine the concurrent validity between the SASISI and the SIPT

A Spearman's correlation was done to determine if there were any relationships between the subtests of the SIPT and the domains of the SASISI. Statistica™ version 11 software was used to do non-parametric statistical analysis (StatSoft, 2012).

- The mean Z-scores for the SASISI domains as well as the SIPT tests were chosen as the variables and imported in the Statistica™ programme.
- The non-parametric data analysis option were chosen, and the Spearman's correlation analysis was selected. This analysis provided information on the rank correlation coefficients and the significance thereof.
- The results were downloaded in a table format for reporting on the results in Chapter 6.

5.4.4 Objective 3: To establish the sensitivity and specificity of the screening instrument.

5.4.4.1 Population and sample selection to establish sensitivity and specificity

The population and sample for the sensitivity and specificity testing was the same as the sample in Objective 2 of Phase two and Objective 2 from Phase three. By using both samples, more data will be available to include in the calculations of the sensitivity and specificity.

5.4.4.2 Data collection tools and data collection procedure to establish sensitivity and specificity

The SASISI Z-scores were used to determine the sensitivity and specificity. The z-scores for each sensory integration domain measured in the SASISI were determined as follows:

- The raw scores for every sensory integration domain was totalled for each child.
- Using the statistical function of Excel, the mean total score was determined for every sensory integration domain, for the whole sample.
- Using the statistical function of excel the standard deviation score was determined for every sensory integration domain, for the whole sample.
- Using the mean total score and the standard deviation score for the sample, each child's z-score was determined for every sensory integration domain.

An Excel spreadsheet was compiled with the sensory integration domains as the headings and the z-scores of the two samples underneath the domain.

5.4.4.3 Data analysis to establish sensitivity and specificity

The sensitivity and specificity of the SASISI was analysed using Medcalc software to determine the Receiver Operating Characteristics (ROC) curve for each domain (MedCalc for Windows, 2017). Each domain was analysed separately using the Z-score for each child as the variable to measure. This variable is compared to a numerical number of 1, which indicates a dysfunction or 0 that indicates no dysfunction. A dysfunction is determined by available cut-off scores, e.g. the SIPT cut-off point for dysfunction is a score below -1SD (Ayres, 2004).

- As no cut-off points are available for this specific sample and the SASISI, the researcher used clinical reasoning to determine cut-off points for each domain. A cut-off of -0.50 SD was decided upon, as a score of -1.00 SD did not yield enough evidence of dysfunction. Each mean z-score that fell below these scores was allocated a numerical value of 1 and each z-score that was above was allocated a numerical value of 0.
- The data for each domain were analysed separately in Medcalc (MedCalc for Windows, 2017). On the data input sheet in the Medcalc software programme, the numerical value indicating a dysfunction or no dysfunction, according to the child's z-score within a domain, was added in the first column. The z-scores for each child within a domain was added in the second column. The ROC curve analysis option was chosen for data analysis and done for each domain of the SASISI.

- The Medcalc data analysis reported on the ROC curve with a graph of the curve, area under the curve data, the Youden index and criterion values and coordinates of the ROC curve.
- Data from the criterion values and coordinates of the ROC curve were used to compile a table showing the areas for each domain where sensitivity and specificity were both a 100%, the ± 95% confidence level and the cut-off point at that specific level.
- The specific cut-off point for each domain was based on the above analysis, and the selected cut-off point indicated a risk of having sensory integration difficulties for each domain.

5.4.5 Summary of the methodology for Phase three

Selected psychometric properties of the newly developed SASISI were determined during Phase three. The methodology explains in detail the processes that were followed for data analysis to determine the content validity, the concurrent validity and the sensitivity and specificity of the SASISI.

5.5 Conclusion

Phase one of the study focused on the methodology used to develop the SASISI. The Delphi process was used in Objectives 1and 2 for item development. Objective 3 described the activity analysis procedure that was used to develop the six activities identified into measurable tasks, actions and observation. Specific administration and scoring guidelines were developed and Objective 4 guided the development of the administration manual and training programme for the administrators of the screening instrument. Following the development of the screening instrument in Phase one of the study, the screening instrument was named the South African Sensory Integration Screening Instrument (SASISI).

Phase two aimed to pilot test the SASISI, to determine the internal construct validity and the clinical utility of the SASISI. Objective 1 of this phase set out the methodology to identify and rectify issues around the equipment used, the instructions and language of administration, as well as scoring, prior to the actual field-testing. A small convenient sample of six children from high and low socio-economic environments were identified for testing during the pilot phase.
Objective 2 of phase two involved the field-testing of the screening instrument to investigate internal construct validity followed. Three samples were identified during this objective, namely a convenient sample of schools from Gauteng and the Dr. Kenneth Kaunda District in North West Province.

From these three schools, a purposive sample of 200 typically developing children, 5 years 0 months to 6 years 11 months of age, and according to specific inclusion and exclusion criteria were selected. A convenient sample of four occupational therapy research assistants were chosen for assessment of the children, as well as for establishing the clinical utility of the instrument in Objective 3.

Rasch analysis was used to determine the internal construct validity of the screening instrument. Interviews with the research assistants who administered the screening instrument during the field-testing were done to determine the clinical utility of the screening instrument. This were the qualitative data set used to explain and elaborate on the findings of the quantitative data sets, staying true to the sequential explanatory design. This concluded Phase two.

Phase three described the methodology in determining the psychometric properties of the SASISI. Objective 1 focused on determining the content validity, whereas Objective 2 included the concurrent validity between the SASISI and the SIPT; Spearman's correlation testing was used to determine relationships between the SASISI and the SIPT. Finally, Objective 3 established sensory sensitivity and specificity through the analysis of the SASISI z-scores and a 0.50SD cut of point using ROC curves. The results of the analyses are reported in Chapter 6.

CHAPTER 6: RESULTS

6.1 INTRODUCTION

The aim of the study was to develop a sensory integration screening instrument for use by newly qualified occupational therapists delivering services in public health, who are not formally trained in sensory integration. Chapter 5 described the methodology followed for each of the three phases of the study. This chapter includes the results for all three phases, based on the objectives for each phase. The results of Phase one will discuss the findings of the Delphi process to choose activities for use as assessments and the development of the tasks and actions for each activity for observation. At the end of Phase one, the newly developed screening instrument was named the South African Sensory Integration Screening Instrument (SASISI). The results of Phase two will show the findings of the pilot study to refine the SASISI prior to field testing on a sample of 200 children to determine the internal content validity. The results of the Rasch analysis in Objective 2 of Phase two will be discussed, followed by the qualitative results of establishing the clinical utility of the SASISI. Finally, the results for the psychometric testing of the SASISI will be discussed including the content validity, concurrent validity and sensitivity and specificity.

6.2 RESULTS FOR PHASE ONE

The aim of Phase one was to develop a screening instrument identifying sensory integration difficulties in children of 5 years 0 months to 6 years 11 months from low socio-economic environments. Four objectives were set to reach this aim, and the results are reported below.

6.2.1 Objective 1: To explore and identify the sensory integration activities for inclusion in the sensory integration screening instrument.

6.2.1.1 Description of sample for first round of the Delphi process

The participants for the first round of the Delphi process were purposively chosen for their expertise in the field of sensory integration. Participants were asked to complete an online open-ended questionnaire and to present their opinion on the behaviours or activities that would contribute information to sensory integration difficulties. The response rate was very low (17%). Nineteen of the 35 participants started the questionnaire, but only six questionnaires were completed in full and available for analysis.

Fincham (2008) found that responses to email or online surveys are lower than other means of data gathering and may only approximate 25% to 30%. Compared to the response rates described by Fincham (2008) this response rate of 17% was very low.

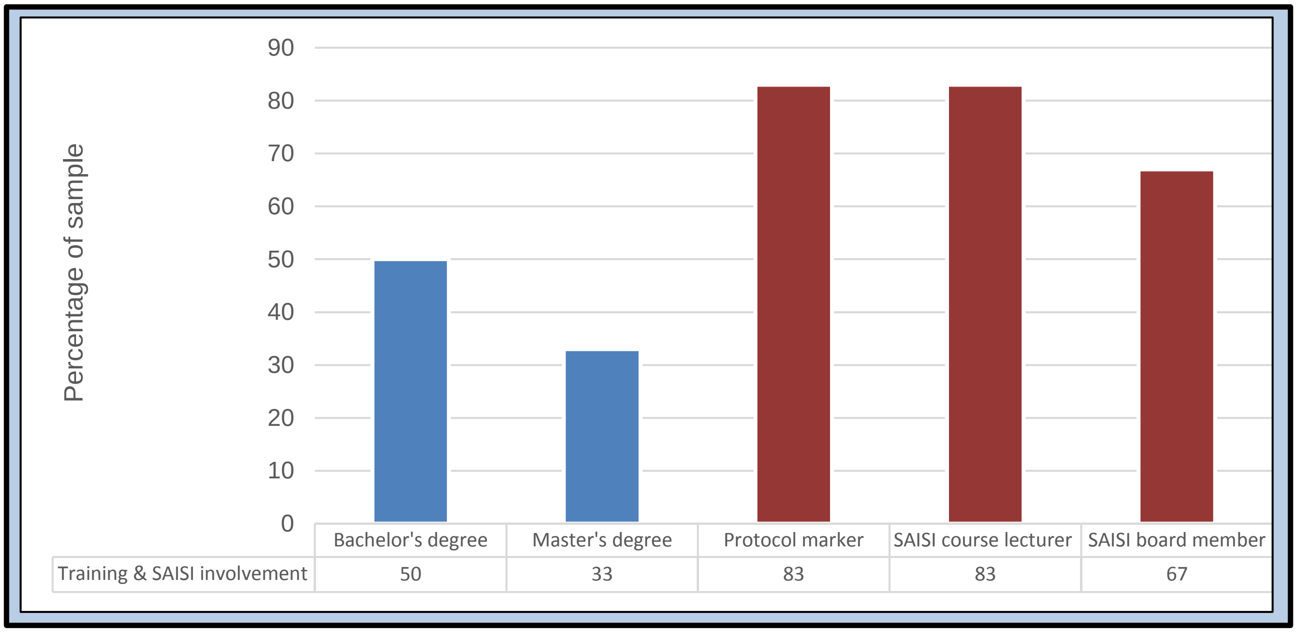


Figure 6.1: Sensory integration expert panel's level of education and involvement in SAISI activities

Figure 6.1 showed that although all occupational therapists within the sample completed a Bachelor's in occupational therapy degree, 50% only had a Bachelor's degree with 33% having an additional Master's degree. A substantial proportion (83%) of the sample indicated they were involved in the South African Institute for Sensory Integration (SAISI) training process as protocol markers, which means they received further mentoring and training to assist with the assessment of children, to improve therapist's theoretical knowledge, as well as the ability to clinical reason using sensory integration knowledge. A similar percentage (83%) of the sample were also involved in lecturing on the SAISI courses and 67% of the sample was on the SAISI board involved in the planning of sensory integration training.

Table 6.1: Sensory integration expert panel's years of experience

	Minimum	Maximum	Mean	Standard Deviation
Years' experience in OT	6.00	21.00	16.00	5.10
Years' experience in SI	3.00	21.00	12.68	6.32

Table 6.1 showed a wide variation in the years of experience and the participants' knowledge on assessment and treatment of sensory integration difficulties, hence the high standard deviations.

6.2.1.2 Findings from the first round Delphi questionnaire

The qualitative open-ended questionnaire aimed to describe the activities or observations, which based on expert opinion, could be used to assess sensory integration difficulties. Rather than providing activities that could be used for observations, participants commented on observations or items from already existing instruments, such as Ayres Clinic Observations or the SIPT. A common theme through all the categories was the use of clinical observations and observing a child participating in an activity as an assessment technique. This finding indicated how critical the observation of the influence of sensory input on activity participation was. Table 6.2 shows the organisation of the codes, subcategories and categories identified during the thematic analysis of the data. Categories included the sensory systems, namely vestibular, visual, proprioception and the tactile systems. The subcategories included domains of sensory integration, namely sensory reactivity, sensory perception or praxis.

Table 6.2: Theme 1: The use of observations to identify sensory integration difficulties

Categories	Subcategory	Code
Vestibular activities	Sensory reactivity	Movement in space Observations: Equilibrium reactions on moving equipment Observations: Being rolled backward on therapy ball
	Sensory perception	Balance with eyes open or closed Postural control Star jumps Hop jump sequence Observations: during playground activities Observations: when climbing stairs
Visual activities	Sensory reactivity	Reactions to light Observations: Eyes water
	Sensory perception	Visual 3D & 2 D Puzzles Observations: the child's reaction to the assessment area Observations: Eye movement Observations of visual perception during desk work
	Praxis	Block construction

Table 6.2: Theme 1: The use of observations to identify sensory integration difficulties- continue

Categories	Subcategory	Code
Proprioceptive activities	Sensory reactivity	Crashing, bumping, bashing Observations: child's responses to proprioceptive input
	Sensory perception	Schilder's arm extension Throwing and catching Observations of timing, force, feedforward, feedback
Tactile activities	Sensory reactivity	Shaving cream Observations: wet textures Observations: behaviours/emotions with different textures Observations: finger paint, mud play, bean boxes
	Sensory perception	Tactile shapes and textures Manual form perception

The qualitative data collection used in the first round of the Delphi process generated a limited number of specific activities to choose from for the next round but provided valuable information on the use of observations as an assessment technique. The data gathered from Objective 1 were used in the quantitative data collection technique in Objective 2 to obtain consensus on activities.

6.2.2 Objective 2: To obtain consensus on the suggested activities chosen for inclusion in the screening instrument.

The results of the first round of the Delphi process were used to design a new questionnaire to gather data until consensus was reached (Cadorin et. al., 2017). As the data gathered in this objective were not sufficient to compile an appropriate second questionnaire, the researcher investigated the literature on child development and sensory integration and available instruments to add activities to the questionnaire. Table 6.3 provides detailed information on the activities chosen for inclusion in the second Delphi questionnaire and the source of the activity.

Table 6.3: The sources used for selection of additional activities for inclusion in the design of the second Delphi questionnaire

Activities to be used for second questionnaire	Source of activity
Activities of daily living	
Dressing (putting on a shirt)	Sensory Profile (Dunn, 2014), Sensory Processing Measure (Parham et. al., 2007)
Undressing (taking of a T shirt)	Sensory Profile (Dunn, 2014), Sensory Processing Measure (Parham et. al., 2007)
Dressing and Undressing (T shirt)	Sensory Profile (Dunn, 2014), Sensory Processing Measure (Parham et. al., 2007)
Putting on socks and shoes	Sensory Profile (Dunn, 2014), Sensory Processing Measure (Parham et. al., 2007)
Eating porridge	Sensory Profile (Dunn, 2014), Sensory Processing Measure (Parham et. al., 2007)
Washing and drying hands	Questionnaire 1 (wet textures), Sensory Profile (Dunn, 2014), Sensory Processing Measure (Parham et. al., 2007)
Washing and drying face	Questionnaire 1 (wet textures), Sensory Profile (Dunn, 2014), Sensory Processing Measure (Parham et. al., 2007)
Brushing teeth	Sensory Profile (Dunn, 2014), Sensory Processing Measure (Parham et. al., 2007)
Brushing hair	Sensory Profile (Dunn, 2014), Sensory Processing Measure (Parham et. al., 2007)
Play type activities	
Household games	Questionnaire 1 (puzzles, 3D, 2D visual activities),
Construction game with blocks	Questionnaire 1, SIPT (Ayres, 1989), MAP (Miller, 1988).
Board games	Questionnaire 1 (puzzles, 3D, 2D visual activities),
Threading beads	MFUN (Miller, 2006), Movement ABC-2 (Henderson et. al., 2007)
Drawing shapes in mud	Questionnaire 1 (mud play),
Making a mud pot	Questionnaire 1 (mud play),
Painting hand prints	Questionnaire 1 (paint),
Making clay shapes	MFUN (Miller, 2006)
School type activities	
Cutting with scissors	Movement ABC-2 (Henderson et. al., 2007)
Drawing with a pencil	SIPT (Ayres, 1989) , MFUN (Miller, 2006), Movement ABC-2 (Henderson et. al., 2007)
Doing a simple maze pattern	DTVP (Hammill et. al., 1993), SIPT (Ayres, 1989)
Matching game	Clinical observation
Colouring in	MFUN (Miller, 2006)
Simple 30 pc puzzle	Questionnaire 1 (puzzles, 3D, 2D visual activities),
Sorting of objects	MFUN (Miller, 2006)
Imitates building a block construction	Questionnaire 1 (block construction, puzzles),
Threading with beads	Movement ABC-2 (Henderson et. al., 2007)
Tie a bow	Movement ABC-2 (Henderson et. al., 2007)
Posting buttons	Movement ABC-2 (Henderson et. al., 2007)
Copies clay forms	Questionnaire 1 (wet textures),

Table 6.3: The sources used for selection of additional activities for inclusion in the design of the second Delphi questionnaire - continue

Activities to be used for second questionnaire	Source of activity
Motor type games	
Standing on one leg	Ayres clinical observations, SAISI gross motor observations (SAISI Research Committee, 2005)
Walk heel-toe on a line	Questionnaire 1 (balance & posture), SAISI gross motor observations (SAISI Research Committee, 2005)
Jump with both feet together	Questionnaire 1 (balance & posture), SAISI gross motor observations (SAISI Research Committee, 2005)
Star jumps	Questionnaire 1 (balance & posture), SAISI gross motor observations (SAISI Research Committee, 2005)
Hop scotch	Questionnaire 1 (balance & posture), SAISI gross motor observations (SAISI Research Committee, 2005)
Throwing and catching a large ball	Questionnaire 1 (throw & catch ball), SAISI gross motor observations (SAISI Research Committee, 2005)
Throwing and catching a tennis ball	Questionnaire 1 (throw & catch ball), SAISI gross motor observations (SAISI Research Committee, 2005)
Bounce a tennis ball with one hand	Questionnaire 1 (throw & catch ball), SAISI gross motor observations (SAISI Research Committee, 2005)
Throw ball at a target	Questionnaire 1 (throw & catch ball), SAISI gross motor observations (SAISI Research Committee, 2005)
Balloon volleyball	Questionnaire 1 (throw & catch ball),

6.2.2.1 Description of sample for first round of the Delphi process

The same expert panel in sensory integration as in Objective 1 were approached to participate in the second round of the Delphi process. The members of the expert panel were asked to choose the activities that in their opinion give the most information on sensory integration difficulties when observed. The response rate for this round was much higher as 21/25 (84%) of respondents completed and returned the questionnaire.

6.2.2.2 Results of the second Delphi questionnaire

The aim was to determine a list of activities that the expert panel agreed on for inclusion in the screening instrument. To ensure rigour in the activity selection process, the degree to which the expert panel agreed on the relevance of an activity as representing a construct of sensory integration was set on 70%. McGinnis et. al. (2010) set a similar level of consensus in a study on assessment of balance.

The results of the questionnaire are presented in in Figure 6.2. The only activity above the 70% cut-off in activities of daily living was the combination activity of dressing and undressing using a T-shirt. The consensus on the separate activities of dressing and undressing were below 70%, as well as all the other activity suggestions.

Out of the 10 suggested motor games, two games, i.e. walking heel-toe on a line and doing star jumps, were endorsed by 80% of the participants. See Figure 6.3.

Figure 6.4 shows the consensus for play activities and where 72% of the expert panel chose the construction games with blocks and 75% chose making clay shapes.

In the area of school activities, the only activity above 70% consensus was cutting with scissor; for all other activities consensus was 52% and below. See Figure 6.5.

The objective for quantitative data collection was reached, as the expert panel reached consensus with more than 70% agreement on six of the activities. Table 6.4 represents the activities that were identified for inclusion in the screening instruments.

Table 6.4: Activities selected by the expert panel with consensus of 70% and above.

Categories	Activities	% Agreement
ADL activities	Dressing and Undressing (T-shirt)	80%
Motor games	Walk heel-toe on line	80%
	Star jumps	80%
Play activities	Construction with blocks	72%
	Making clay shapes	76%
School type activities	Cut with scissors	72%

Objective 3 focused on the analysis of these six activities into measurable observations to guide the construct format and scoring system.

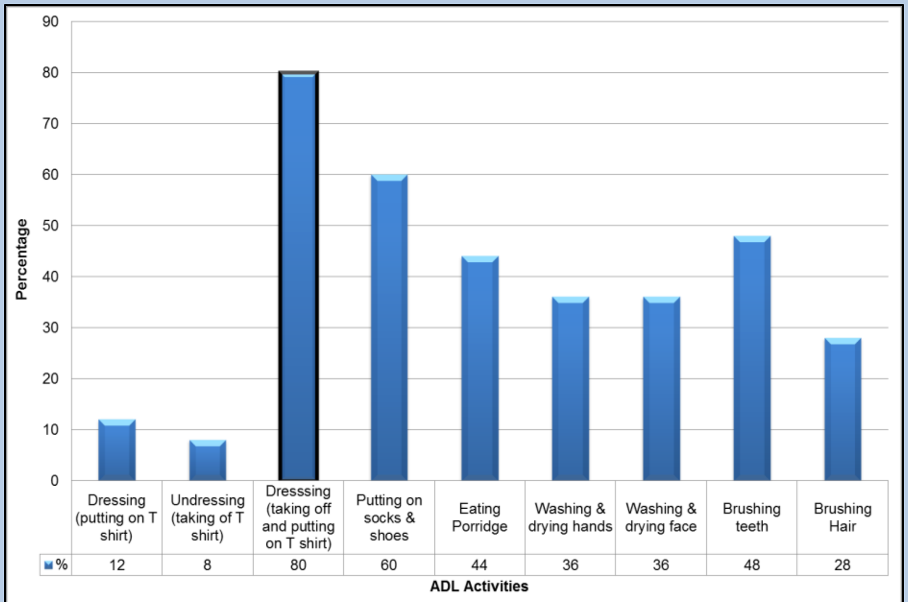


Figure 6.2: Consensus reached on activity choices from activities of daily living.

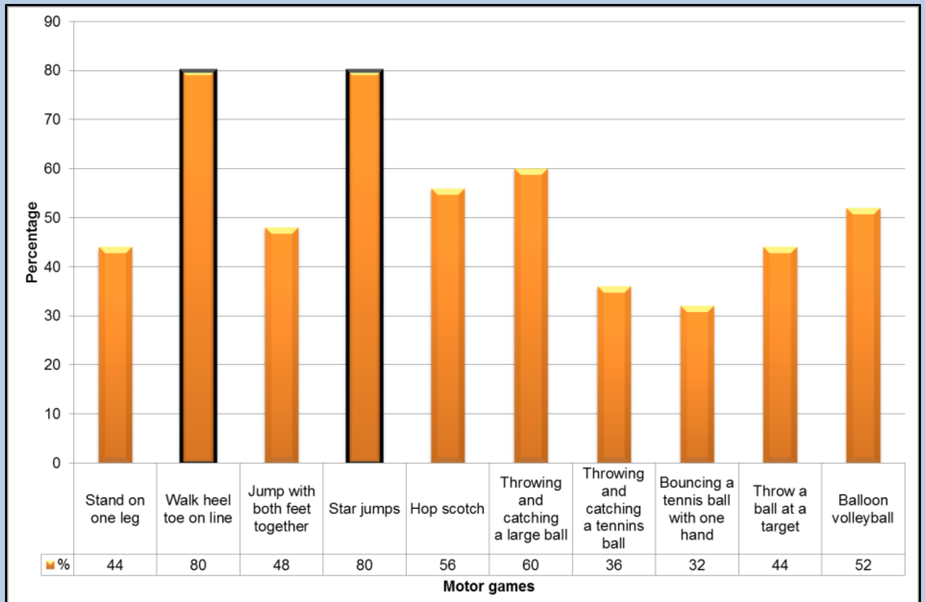


Figure 6.3: Consensus reached on activity choices from motor type activities.

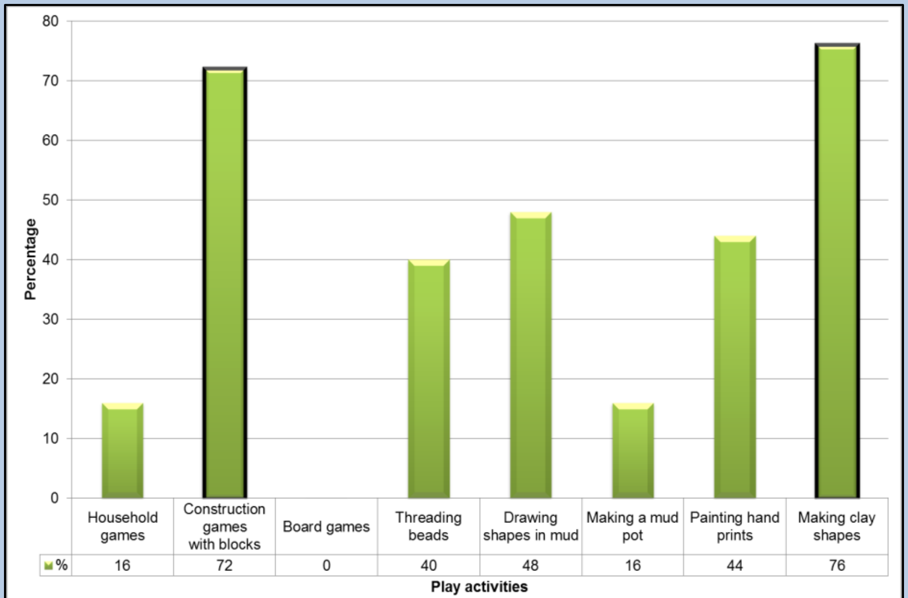


Figure 6.4: Consensus reached on activity choices from play type activities.

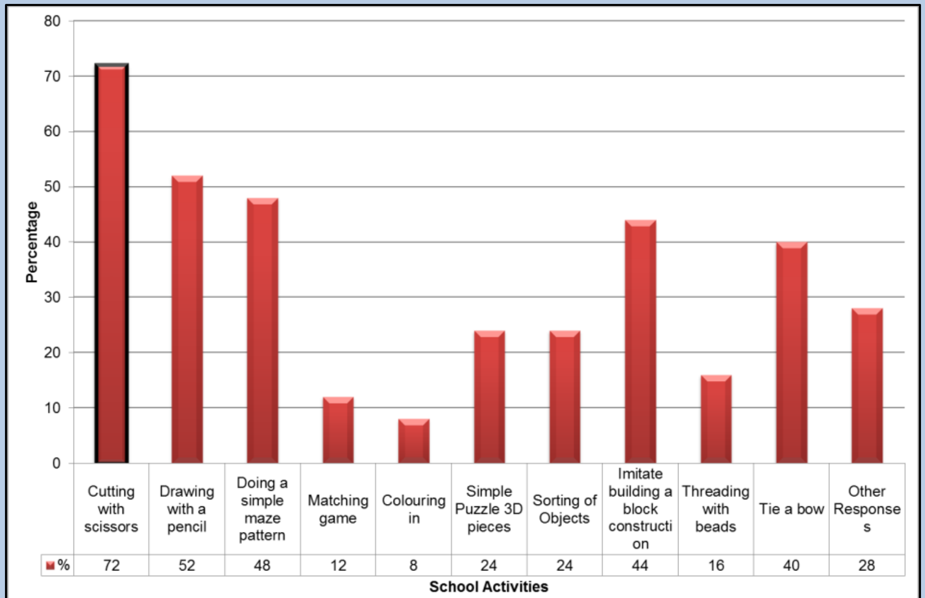


Figure 6.5: Consensus reached on activity choices from school activities.

6.2.3 Objective 3: To construct an administration format and scoring system using activity analysis

Activity analysis was used to develop the administration and scoring format for the sensory integration screening instrument. The methodology for Objective 3 was described in Chapter 5, section 5.3.2. The results will report on the description of how the activities are executed, a description on the identification of the nine sensory integration domains and the breakdown of the activities in measurable actions.

6.2.3.1 Description of how the activity is executed

The activity analysis firstly guided the breakdown of the activity by describing the following: how the activity is executed and the tools and resources needed. Each activity was broken down into a sequence of tasks that require the completion of specific actions. Table 6.5 shows the description of the tasks involved in the execution of the activities.

Table 6.5. Description of how activities are executed

Name of activity	Description of how activity is executed & sequence of tasks	Culturally appropriateness	Tools and resources needed
Dressing and undressing activity	The child will be asked to do the following tasks: • Task 1: Take off their shirt, cardigan or jacket • Task 2: The child will be asked to put it on again. The administrator will observe the actions of the child in completing these tasks. Observations of quality of execution, if the child need's assistance and what the motor control is like during the execution.	Dressing and undressing is a universal skill in all cultures. Dressing and undressing are self-care tasks that are expected of a child from 5 years to 6 years 11 months. At this age, they should be able to do this task independently. By using the child's own clothing, it will be a familiar task for the child.	Child's own garment e.g. T-shirt, cardigan, jacket, etc. The activity can be executed at school, home or clinic within a secluded area.

Table 6.5. Description of how activities are executed - continue

Name of activity	Description of how activity is executed & sequence of tasks	Culturally appropriateness	Tools and resources needed
Walking heel-toe on a line	The activity will involve the following tasks: • Task 1: Walking on a line heel-toe with eyes-open • Task 2: Walking heel-toe with eyes-closed • Task 3: Walking heel-toe and backwards.	Heel-toe walking is appropriate for this developmental age group. From 4 years to 10 years, walk on line of 2 m or longer. This activity is not linked to a specific culture and can be done by children from all cultures.	A pre-prepared line of 2 m long taped on the floor with masking tape.
Star jumps:	The star jump activity will include the following tasks: • Task 1: Jump with feet together • Task 2: The child will jump with both feet and arms (with arms only up to shoulder height). • Task 3: The child full jump a full sequence (both arms and legs) as fast as possible within 15 seconds.	This activity is an age appropriate activity for this age group. This activity is not linked to a specific culture. A child from 5 years to 6 years 11 months should be able to complete this activity with minimal problems.	No equipment needed. This activity can be done in or outside a building Only need space for jumping.
Construction blocks:	The activity included the following tasks. • Task 1: This activity starts with asking the child to find the blocks in sand with their eyes closed, before they build the required 3-D construction. See how many blocks the child can find in 2 minutes. The step in the sand was added to provide information on tactile discrimination as well as tactile reactivity. • **2. Task 2:** Formal building of simple patterns. The child is asked to copy the same patterns that were built by the examiner. ➢ Tower with 3 blocks ➢ Tower with 6 blocks ➢ Bridge with 3 blocks • **Task 3:** Ask the child to copy the same patterns that they see on the ***picture.*** These patterns will be more complex. ➢ Complex tower with 10 blocks ➢ Complex bridge with 5 blocks ➢ Complex bridge with 6 blocks	Blocks and sand are played with across cultures and genders within South Africa. This activity is also developmentally appropriate as children of 5-6 years enjoy construction games and is equal fun for males and females	Blocks are needed. These can be made from left over wood. Sand needs to be washed to ensure that it is clean and free from rocks or other items.

Table 6.5. Description of how activities are executed - continue

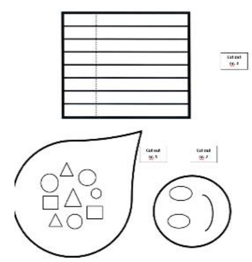
Name of activity	Description of how activity is executed & sequence of tasks	Culturally appropriateness	Tools and resources needed
Making clay shapes:	The activity includes the following tasks • Task 1: The child is asked to roll clay worms as demonstrated by the administrator. This includes several types of movements, e.g. ➢ rolling between both hands ➢ rolling with one hand on the table, left and right ➢ rolling with both hands together on the table. • Task 2: The administrator draws a picture on the back of the child's hand. **I, -, +, O** • Task 3: The child uses the clay worms to make the shape drawn on the back of their hand.	Sand and clay are played with across cultures and genders within South Africa. This activity is also developmentally appropriate as children of 5-6 years enjoy construction games and is equal fun for males and females.	Clay or playdough. This can be made at home or is easily available in a store
Cutting with scissors:	The cutting with scissors activity chosen during objective two did not include detail on what needs to be cut and how. A picture of a spider is used with different shapes that need to be cut out and pasted together. The activity was expanded into the following tasks: • Task 1: Colouring in: The child colours the body of the spider. • Task 2: Cutting: The child is asked to cut the rectangles of the spider's legs, the circle of the spider's body and the oval of the spider's face. • Task 3: Folding legs: The rectangle shaped legs are folded to the spider's foot. The administrator demonstrates to the child how to fold the rectangles • Task 4: Sticking: The legs of the spider, the circle of the body and the oval of the head are pasted together according to an example. The child can take the end-product home at the end of the assessment.	A picture of parts of a spider is used for this activity, as a spider is known to children of all ages and cultures. This activity is also developmentally appropriate as According to the Peabody developmental scales (Folio and Fewell, 2000) children from 5-6 years 11 months will be able to cut a more complex shapes such as circle, square etc. The shapes are graded for cutting from easy, rectangles that only requires straight cutting, to the circle and oval that require going around curves.	Picture of a spider  Colouring in pens Scissors Glue

Table 6.5. Description of how activities are executed - continue

Name of activity	Description of how activity is executed & sequence of tasks	Culturally appropriateness	Tools and resources needed
Sensory reactivity and organisation of self and the environment:	The execution of the above six activities are done in a specific order starting with the non-threatening dressing and undressing activity and getting progressively more difficult to the cutting activity. The construction with blocks activity (finding blocks in sand), the clay activity (the texture of the clay) and the cutting activity (the glue sticking to the child's hands) include elements that may elicit sensory reactivity behaviours. The execution of the activities may also provide valuable information on how the child organise themselves and their environment. Although specific observations were developed for each activity, some behavioural observations are frequently seen in all the activities or the child's behaviour in general. These observations describe the client's attention and focus, distractibility, reactivity to sensory input and the way the child handles information from the environment. Organisation of self and the environment included information on how the child organises himself, his approach to the task and the environment during the screening assessment. These observations were therefore added to determine the sensory integration domains of sensory reactivity, organisation of space and the environment and organisation of self and behaviour.		

Following the description of how the activities are to be executed, it was important to describe the underlying sensory integration demands according to nine sensory integration domains.

6.2.3.2 Description of the underlying sensory integration domains

Smith Roley and Schaaf (2006) proposed six components of sensory integration, namely sensory registration and arousal, sensory reactivity, sensory perception, skills, praxis and organisation. The researcher identified nine domains of from these sensory integration components for measurement, namely sensory perception, skills broken down into postural ocular control, bilateral integration and sequencing, handling of objects and visual form and space and praxis. The domains of sensory reactivity, organisation of space and environment and organisation of self and behaviour were included as final observations. See the domains circled in red in Figure 6.6, (Ayres, 1989; 1972a; 2005; Mailloux et. al., 2011; Mailloux et. al., 2018; Smith Roley et. al., 2001a; Schaaf and Mailloux, 2015).

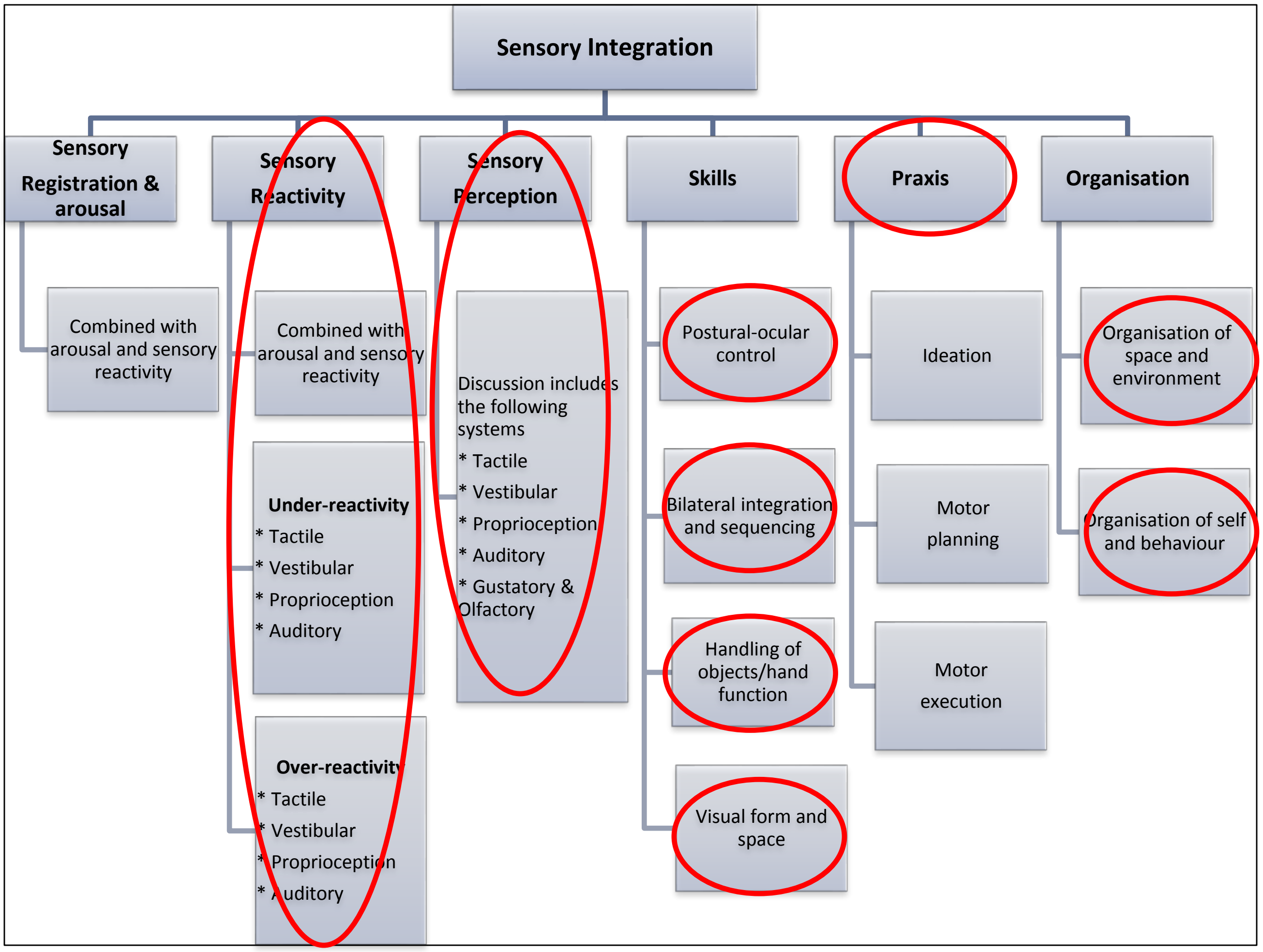


Figure 6.6: Sensory integration components and the resultant sensory integration domains chosen, in red, for inclusion in the screening instrument(Smith Roley and Schaaf, 2006)

These nine sensory integration domains are described in Table 6.6 and included a description of the functional influence of the domain that can be observed in the child's actions or abilities.

Table 6.6. Description of the nine sensory integration domains and the role of each domain in functional actions/abilities

SENSORY INTEGRATION DOMAINS	FUNCTIONAL ROLE OF THE SENSORY INTEGRATION DOMAIN
SENSORY REACTIVITY OR MODULATION	Smith Roley et. al. (2001a: 57) describe sensory modulation in behavioural terms as “the ability to regulate and organise responses to sensation in a graded and adaptive manner, congruent with situational demands.” Recently the term sensory modulation was changed to sensory reactivity (Schaaf and Mailloux, 2015). Under and Over reactivity can be seen in the following systems: Visual system, Proprioceptive system, Tactile system, Auditory system and Vestibular system.
SENSORY PERCEPTION OR DISCRIMINATION	According to Ayres (2005: 201), sensory discrimination is “the ability to perceive various aspects of sensation within a system.” Recently the term sensory discrimination was changed to sensory perception (Schaaf and Mailloux, 2015). Include visual perception, tactile perception, vestibular perception, proprioceptive perception and auditory perception.
POSTURAL OCULAR CONTROL SKILLS	Kramer and Hinojosa (2010: 209) define postural control as “the ability to assume and maintain body positions during static and dynamic movement.” **Include the following actions or abilities:** Eye movement/ocular motor control, postural tone and control, body scheme, proximal stability, balance reactions, righting and equilibrium reactions and postural adjustment or background movement.
BILATERAL INTEGRATION AND SEQUENCING SKILLS	The ability to use two parts of the body together in a coordinated manner during motor activities. Deficits in Bilateral integration are especially linked to projected action sequences. Projected action sequences is the ability to predict movement events in the environment and to adjust the movement in order to meet the future conditions of the environment (SAISI Research Committee, 2005). **Include the following actions or abilities:** Coordinated & rhythmic sequences of movements, projected action sequences and midline crossing.
PRAXIS SKILLS	Praxis include ideation, motor planning and motor execution. Ideation is the cognitive process that involves recognising the possibilities of an object or movement and forming an idea of what to do with the object or movement (Bundy et. al., 2002). Motor planning is the process between ideation and action and involves the organisation of motor actions. Motor execution is the last step in executing motor act/tasks and involves knowledge of the performance of a task and the consequent result.
HANDLING OF OBJECTS	**Handling of objects include the following actions or abilities:** Reach, grasps with no thumb opposition, grasps with thumb opposition, release: letting go, in-hand manipulation, tool use/ scissor grip and bilateral hand use.
VISUAL FORM AND SPACE SKILLS	**Visual form and space skills include the following actions or abilities:** Visual memory, object & form perception, spatial perception and visual motor integration.
ORGANISATION OF SELF, BEHAVIOUR AND THE ENVIRONMENT	**Ability to organise self within the environment** This is the ability to engage and deal with themselves and the environment in a useful way (Smith Roley et. al., 2001a; Ayres, 2005). **Include the following actions or abilities:** Work speed and use of time, concentration & focus, follow of instructions, motivation to participate (inner drive).

Each sensory integration domain was further described in terms of the possible functional observations indicating sensory integration difficulties. Table 6.7 provides an example of the format that was used to develop the full analysis of the sensory integration domains and functional observations, with the full analysis of all domains described in Appendix A.

Table 6.7. Analysis of sensory integration domains and functional observations

Key domain of sensory integration	Area of functional input	Functional description of domain (influence on child's actions and abilities)	Possible functional observations during testing that can indicate sensory integration difficulties
Postural ocular control. Involves the vestibular, proprioceptive and visual systems	**Eye movements/ ocular motor control**	Voluntary eye movements that consists of visual tracking (slow eye movements) and quick localisation. (Bundy et. al., 2002) The proprioceptive receptors play a role in stabilising the head for movement during activities according to the task demands and coordinate the movement of the eyes, head and neck. (Bundy et. al., 2002)	• The child has difficulty in scanning his environment for the objects needed in the activities. • Child complains of blurred vision. • The child needs to hold objects close to his face to see it properly. • Have difficulty to build the blocks activities from the 3D or 2D examples. • Have difficulty to focus on the activities, e.g. block activity or scissor activity. • The child needs to move their whole body to look at the therapist or objects in the environment (Lane, 2005).

(Smith Roley et. al., 2001a; Bundy et. al., 2002; Smith Roley and Schaaf, 2006; Lane and Bundy, 2012; Kramer and Hinojosa, 2010).

6.2.3.3 Breakdown of the activities into measurable actions

The activity analysis finally guided the breakdown of the activity into a sequence of tasks that require the completion of specific actions. Fisher and Jones (2010) proposed that these actions are observable and provide information on the performance of the client. The execution of these actions was measured against the sensory integration observations for the nine sensory integration domains. The breakdown includes the task within the activity, the actions observed in executing the task, the underlying sensory integration domain that is measured within the action, the observations within the SI domain that can be indicative of difficulties when executing the action and the scoring of the observations. See Figure 6.7 for an example of the breakdown of the dressing activity that involves the task of taking off the garment/T-shirt.

Level 1 Task within the activity	Level 2 Actions required to complete task 1	Level 3 Underlying Sensory integration domain for measurement	Level 4 Example of observation of Sensory Integration domain for scoring	Level 5 Scoring
Task 1:	**Action observed**	**Sensory integration Domain measured**	**Observations of actions for scoring**	**Scoring**

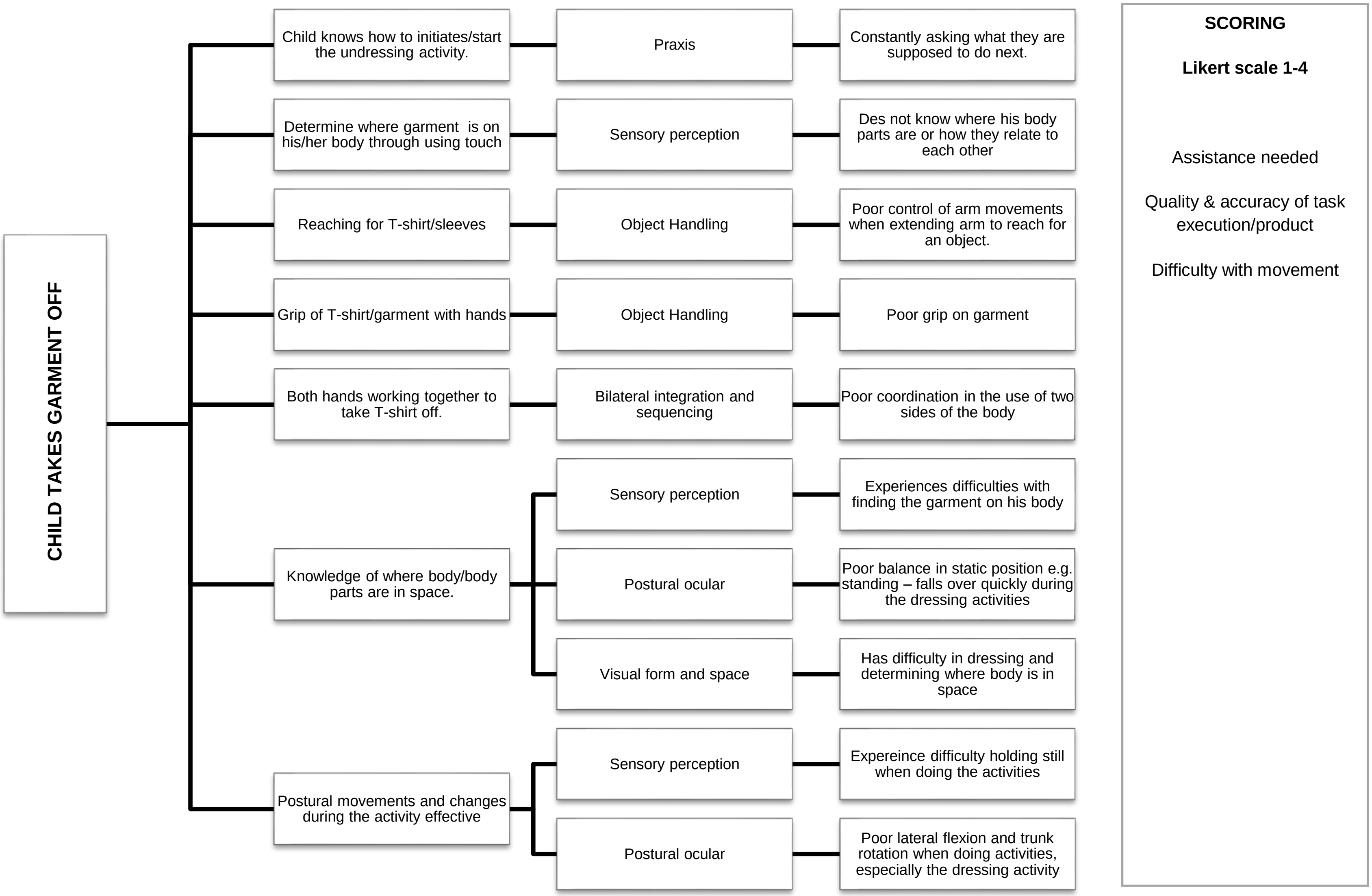


Figure 6.7: Activity analysis breakdown of measurable actions for scoring

6.2.3.4 Development of an administration and scoring format for the screening instrument

Criteria for an administration and scoring format were set in Chapter 5, in 5.2.3.4. Table 6.8 describes the administration format according to the criteria set for the administrative format. The full administration format for each activity is described in the screening instrument administration manual (Appendix F)

Table 6.8: Description of the administrative format

	Dressing & Undressing	**Heel-toe walking**	**Star jumps**	**Building blocks activity**	**Clay forms activity**	**Spider cutting activity**
Administration mode	Individual	Individual	Individual	Individual	Individual	Individual
Description of activity execution	Task 1: The child takes off a garment (jacket or T-shirt). Task 2: Put a garment (jacket or T-shirt) back on again.	Task 1: Walking on a line heel-toe with eyes-open. Task 2: Walking heel-toe with eyes-closed. Task 3: Walking heel-toe and backwards.	Task 1: Jump with feet together. Task 2: The child will jump with both feet and arms (with arms only up to shoulder height). Task 3: The child full jump a full sequence (both arms and legs	Task 1: This activity starts with asking the child to find the blocks in sand with their eyes closed. **Task 2:** Formal building of simple patterns: Tower with 3 blocks. Tower with 6 blocks. Bridge with 3 blocks. **Task 3:** Ask the child to copy the same patterns that they see on the ***picture.*** These patterns will be more complex. Complex tower with 10 blocks. Complex bridge with 5 blocks. Complex bridge with 6 blocks.	The child rolls clay: Task 1: The child is asked to roll clay worms as demonstrated by the administrator; this includes several types of movements, e.g. rolling between both hands, rolling with one hand on the table, left and right, rolling with both hands together on the table. Task 2: The administrator draws a picture on the back of the child's hand. **I, -, +, O** Task 3: The child uses the clay worms to make the shape drawn on the back of their hand.	Task 1: Colouring in: The child colours the body of the spider. Task 2: Cutting: The child is asked to cut the rectangles of the spider's legs, the circle of the spider's body and the oval of the spider's face. Task 3: Folding legs: The rectangle shaped legs are folded to the spider's foot. The administrator demonstrates to the child how to fold the rectangles Task 4: Sticking: The legs of the spider, the circle of the body and the oval of the head are pasted together according to an example. The child can take the end-product home at the end of the assessment.

Table 6.8: Description of the administrative form – continue

	Dressing & Undressing	Heel-toe walking	Star jumps	Building blocks activity	Clay forms activity	Spider cutting activity
Structuring of activity for administration	Private area or room. Child in standing position	Open area to draw a line of 2 meters with tape	Open area where child can jump without bumping into objects	Sitting at a small table and chair	Sitting at a small table and chair	Sitting at a small table and chair
Equipment needed for activity	No equipment. Child uses own T-shirt or jacket. Child to take off socks and shoes for heel-toe activity	Line on floor (use tape 2 meters long). Child to take off shoes and restrictive clothing	No equipment needed. Child to take off shoes and restrictive clothing.	Container with clean sand ***Wooden blocks*** 14 Wooden blocks 30mm x30mm x30 mm 10 Wooden blocks 20mm x 20mm x 20 mm to put into the sand.	Play dough in a primary colour – yellow/red/blue	Colour pencils. Children's left and right-handed scissors with blunt nose. Printed sheet with picture of spider. Example of paper spider Glue (Pritt / Glue stick).
Administration time	± 5 minutes	± 5 minutes	± 5 minutes	± 10 minutes	± 5 minutes	± 15 minutes
Administration order	First	Second	Third	Fourth	Fifth	Last This activity provides an end-product that the child can take home.

The scoring process is based on the observations of the child's actions, behaviour and performance in each activity, as identified through the activity analysis. As the screening instrument is aimed at occupational therapists with only basic knowledge of sensory integration, the burden on the examiner is minimised by providing specific observations to aid with scoring as seen in table 6.9.

Table 6.9: Description of the scoring format

Scoring criteria	Description of the scoring format
Administrator scoring qualifications	Administrators should be occupational therapists with basic knowledge of sensory integrations. The administrator is required to attend a training session on the administration and scoring of the sensory integration screening instrument. Following the training session, the administrator should complete scoring of at least five typical cases. These cases need to be submitted for peer review to ensure the administrator is scoring appropriately.
Scoring response	The scoring response is based on observations of the child's participation in each activity. Scoring criteria were set and based on the amount of assistance the child needed to participate or complete a task, the quality and accuracy in the execution of a task and the ability to move with good coordination, rhythm and fluency. A response format, namely a Likert scale, was decided upon as it provides the administrator the opportunity to rate a behaviour or observations in terms of the provided criteria in such a way that scores improve equally from a score of one to a score of four. The scale was developed with four categories (or scores) of responses and ordered in ascending order where category 1 represents poor quality and accuracy, difficulties and poor control in movement and the child needs assistance to perform the step (De Kock et. al., 2013). Category 4 indicates that the child can participate in the step of the activity with accuracy, good quality, control, and without any assistance.
Scoring specifications	Scoring specifications specified that some observations be firstly considered for the 1) assistance needed, the 2) quality and execution of the task and the 3) difficulties with movement and coordination. The administrator scores only the area of concern out of the three options including assistance needed, quality and accuracy and movements. If the child display difficulty in one or more area, the lowest score will be used. **Description of scoring system format for the sensory integration screening instrument**

Scale	Assistance needed	Quality & accuracy of task execution/product	Movements
1	Unable to execute activity even with verbal/physical assistance.	Poor quality and severe difficulties with accuracy of task/product execution.	Severe difficulties with coordination, speed and control of movements.
2	Child needs verbal/physical assistance during all stages of the activity.	Poor quality and moderate difficulties with accuracy of task/product execution.	Moderate difficulties with coordination, speed and control of movements.
3	Child needs verbal/physical assistance once/twice during activity.	Poor quality that improves with practice and mild difficulties with accuracy of task/product execution.	Mild difficulties with coordination, speed and control of movements.
4	Can complete without assistance, with good quality.	Good quality execution. Speed and coordination	No difficulties with movements. Good coordination, speed and control of movements.

Table 6.9: Description of the scoring format – continue

<table>
<tr><th>Scoring criteria</th><th>Description of the scoring format</th></tr>
<tr><td>Scoring of action</td><td>
Observe the child while the child is executing the activity. Each action within the activity measures a domain of sensory integration that is represented by a column in the scoring sheet. This domain for the action of the activity will be indicated by a white block on the scoring sheet. The score for the specific step should be written in this white block.
The score chosen is written in the white box next to the step being observed. If there is more than one white box next to the observed step the score needs to be written in both boxes.
Example: The administrator observes the child’s ability to start the sequence of a movement and continue in the correct order. This step measures the underlying sensory integration domain of bilateral integration and praxis. The administrator observes the child’s ability to start and continue the sequence to measure bilateral integration and allocate a score, e.g. 3, that is written in the white box below bilateral integration. The ability to start the sequence is an indication of praxis and the administrator allocate a score e.g. a 2 to praxis and write it in the white box below praxis
Scoring sheet example
<table>
<tr><th></th><th></th><th>Sensory perception</th><th>Postural ocular</th><th>Bilateral integration</th><th>Praxis</th><th>Object handling</th><th>Visual spatial</th><th>Comments</th></tr>
<tr><td>PART 4: Sequence</td><td>Can start sequence and continue in correct order.</td><td></td><td></td><td>3</td><td>2</td><td></td><td></td><td></td></tr>
<tr><td></td><td>Good grading of movement</td><td>3</td><td>2</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Coordination of arms and legs bilaterally.</td><td></td><td></td><td>1</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Transitioning from previous activity</td><td></td><td></td><td></td><td>2</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">TOTAL</td><td>3</td><td>2</td><td>4</td><td>4</td><td>0</td><td>0</td><td></td></tr>
</table>
Full scoring sheets for each of the activities are available in the manual (Appendix F).
</td></tr>
<tr><td>Procedure total scoring</td><td>The procedure to determine total scores were developed and included firstly the summing of each sensory integration domain, e.g. sensory perception, to determine a score for the child out of the final score. The final score for each domain was determined by taking the number of items included in the domain times four as the highest score. To determine the total scores included firstly the summing of each sensory integration domain, e.g. sensory perception, to determine a score for the child out of the final score. The final score for each domain was determined by taking the number of items included in the domain times four as the highest score. See Table 6.10 for a description of the total scoring and interpretation of the total scores.</td></tr>
</table>

The total scores for each sensory integration domain in an activity should to be determined by adding all the scores in the white boxes under the sensory integration domain. All the total scores are carried over to the front page of the scoring sheet, for example all the scores for sensory perception of the six activities are written on the front page, as seen in Table 6.10.

The combined score for a domain is written on the front page and totalled. The total will indicate if the child is typical, possible risk or at risk for a sensory integration difficulty. A child at risk should be referred for a full sensory integration assessment or receive a home program to facilitate the development of sensory skills.

The **total score for a domain** is written on the front page **and totalled**. The total will indicate if the child is **typical, possible or at risk** for a sensory integration difficulty.

Table 6.10 An example of the front-page scoring system

	Sensory Discrimination	**Postural Ocular control**	**Skills: Bilateral integration**	**Praxis**	**Handling Objects Hand function**	**Skills: Visual form and space**		**Sensory Modulation**	**Organization of space and form**	**Organization of behaviour**
Dressing & Undressing	14/**28**	24/**40**	15/**20**	20/**44**	9/**12**	11/**24**				
Heel-toe walking	**/56**	**/68**	**/20**	**/24**	**/0**	**/16**				
Star jumps	**/44**	**/44**	**/48**	**/40**	**/0**	**/12**				
Blocks game	**/32**	**/16**	**/16**	**/56**	**/32**	**/72**				
Clay game	**/60**	**/20**	**/24**	**/52**	**/44**	**/24**				
Spider/scissor game	**/36**	**/24**	**/24**	**/64**	**/40**	**/36**				
TOTAL SCORES	**/256**	**/212**	**/142**	**/280**	**/128**	**/184**		**/32**	**/24**	**/44**
Typical	**193-256**	**160-212**	**109-142**	**211-280**	**97-128**	**139-184**		**25-32**	**19-24**	**34-44**
Possible Risk	**129-192**	**107-159**	**73-108**	**141-210**	**65-96**	**93-138**		**17-24**	**13-18**	**23-33**
At Risk	**64-128**	**53-106**	**36-72**	**70-140**	**32-64**	**46-92**		**8-16**	**6-12**	**11-22**

Only the total scores for the sensory reactivity, organisation of space and the environment and organisation of self and behaviour are written on the front page of the scoring sheet, as these scores are based on participation in all six of the activities. Scoring sheets for each of the activities were developed to simplify the scoring process. Examples of the scoring sheets for each activity were included in the manual (Appendix F).

6.2.4 Objective 4: To compile an administration manual and clinician training programme

The administration manual provides information on how the instrument was developed, the administration and scoring requirements and the interpretation of scores. Specifications for the administration manual were set in the methodology in Chapter 5.

6.2.4.1 The final format of the administration and scoring manual

- Test specifications: Within the first part of the administration manual the following test specifications were described, e.g. the purpose of the screening instrument, intended population, definitions of the construct measured, the item format and the ordering of the items and sections, as discussed in Table 6.11 and Appendix F.
- Administrator requirements: The second part of the administration manual considered the requirements for test administrators to administer the screening instrument, e.g. administrator needs to be an occupational therapist, the administrator need to complete training on the use of the screening instrument before administrating it, as discussed in Table 6.11 and Appendix F. The administrator needs to complete and pass five scoring assessments following the training before the administrator can score independently. As the screening instrument is a performance measure, human judgement may introduce bias if no proper measure is in place to monitor administrator training (American Educational Research Association et. al., 2014).
- Administration of activities: The third part of the manual focused on the administration instructions for the activities as seen in Appendix F. Detailed instructions were developed to guide the test administrator to administer the screening instrument in a standardised way. Overall instructions were provided for the order of administration of the activities, the test kit that included the equipment needed, the testing environment and the documentation needed for the administration of the instrument. Documents such as the background information sheet with the child's name, age, date of birth and home language, as well as the activity scoring sheet and the worksheets needed for each activity were included in the manual.
- Instructions: Detailed instructions on how to administer each activity were developed and included the length of the activity, the specific materials to be used, step-by-step verbal instructions to the children, practice opportunities for the specific activity, scoring procedures and scoring sheets. An example of the instructions for the heel-toe walking included verbally instructing the child to walk on a straight line by putting the heel to the toe with each step. The administrator first demonstrates the action to the child while explaining verbally.

The administrator allows the child two opportunities to execute the task with eyes open and another two with eyes closed. Instructions were developed to be short and for possible adaptions for an activity if the child does not understand the instruction, or if the child needs extra assistance. Table 6.11 describes the test specifications for the administration manual format in more detail

Table 6.11 Description of test specification for the administration manual format

TEST SPECIFICATION	DESCRIPTION OF SPECIFICATION FOR THE SENSORY ITNEGRATION SCREENING INSTRUMENT
Purpose and intended use of the screening instrument	The purpose of the screening instrument is to determine the risk of having sensory integration difficulties in children living in low socio-economic environments. The screening instrument will be norm referenced as it reflects a child's performance compared to other children of the same age (Kielhofner, 2006b).
Age range	The screening instrument is for use with children from 5 years 0 months to 6 years 11 months. Most of the children in South Africa access formal schooling at this age.
Reason for specific age group	<u>This age group was chosen for the following reasons:</u> ❖ It will be beneficial to identify problems earlier in the school environment in order to arrange for intervention. ❖ According to a document review done at a hospital in North West Province, 70.3% of the children referred for services where between 5 years and 6 years 11 months (Van der Linde, 2009). ❖ This is traditionally the age group when children attend school for the first time in South Africa and are identified as having difficulties and referred for occupational therapy intervention (Van der Linde and Olivier, 2010). ❖ The age range for using the SIPT test (the gold standard test) is within 4 years 0 months – 8 years 11 months of age (Ayres, 2004).
Gender	Male and female children
Context children live in	Children living within low socio-economic environments that: ❖ either attend a non-paying or quintile one school, ❖ have a care-giver that receives a child dependency grant from the department of social development to financially care for the child, ❖ receive financial assistance from the school or government or charity, ❖ receive financial assistance from a NGO, or ❖ receive help from a food scheme.
Overall length of the test	The overall sensory integration screening instrument should be no longer than 30 – 45 minutes depending on the child's abilities. The child's participation in an activity is measured through observations on the amount of assistant the child needs, the quality of performance and the control in the execution of movements. Each activity takes between 5- 10 minutes, depending on the child's abilities.
Item response format	The child performs the activity while the administrator observes the child. Each step of the activity has specific observations that may indicate difficulties in the underlying sensory domain. The administrator responds by providing a score based on a Likert scale from 1-4 considering observations on the amount of assistant the child needs, the quality of performance and the control in the execution of movements.
Mode of administration	The activities are administered individually. Due to the format of the item observation, it will be difficult for the administrator to observe the child's abilities when their attention is divided between two or more children.

6.2.4.2 Description of the format of the training programme for the sensory integration screening instrument

A three to four-hour internet-based training programme was developed to make training resources more accessible to occupational therapists working in rural areas. The online training programme is hosted on the University of the Witwatersrand, School of Therapeutic Sciences Moodle e-learning platform. Students gain access to the training programme through a password ensuring confidentiality (Appendix G). The use of the Moodle online platform allows the researcher to monitor the training programme, e.g. access of learning material, electronic quizzes and discussion forums.

The first part of the training programme consisted of online sessions that occupational therapists could work through in their own time and according to their own pace. Learning resources such as PowerPoint presentations, documents such as the administrator manual, scoring sheets and questionnaires, quizzes, as well as a discussion group were made available to enhance the learning process. Four topics and related learning objectives for the training programme were developed to ensure that occupational therapists knew exactly what information was important and to determine if occupational therapists mastered the specific skill. Table 6.12 provides information on the topics and the learning objectives of the training programme.

Table 6.12: Topics and learning objectives for the training programme

Topic	Learning objectives	Delivery
Background on the development of the screening instrument	On completion of the topic the occupational therapist will be able to discuss: • The background and reasons for the development of the sensory integration screening instrument. • The realities of low socio-economic environments in South Africa. • The influence of growing up in low socio-economic environments on a child's development. • The basic theory on sensory integration.	Online
Administration and scoring of the screening instrument	On completion of the topic the occupational therapist will be able to describe and demonstrate: ➢ The specific equipment that is needed for each item. ➢ The structuring of the environment, child and administrator for the administration of the activity. ➢ The administration and verbal instructions for each item. ➢ The scoring for each individual activity and the overall scoring.	Online Face to face session
The importance of ethical testing practices	On completion of the topic the occupational therapist will be able to: ❖ Describe what ethical research behaviour entails. ❖ Describe how the research process adheres to the ethical guidelines. ❖ Describe the ethical criteria set for research and assessment by the University of the Witwatersrand.	Online
Administration and scoring workshop	A workshop that focused on the practical skills in administering and scoring of the screening instrument. Learning resources included the watching of videos for the scoring of the activities. The scoring of each video was discussed in a group setting to identify and resolve scoring discrepancies.	Face to face session

Following the completion of the training programme, newly trained occupational therapists need to practice the administration and scoring at home and submit five cases for assessment to the researcher to determine interrater reliability for new administrators.

6.2.5 Summary of the results of Phase One

The first round of the Delphi process established an overall theme of using clinical observations for assessment but did not provide sufficient activities for use in the next round. The second questionnaire was designed using information from the first round, the literature and other standardised assessments. The second round of the Delphi process generated a 70% consensus for six activities namely, dressing and undressing, walking heel-toe, star jumps, building block constructions, making clay shapes and cutting with scissors. Activity analysis was used to break the activities down into observable steps according to the underlying sensory integration domains and their components. An administration and scoring format were developed to adhere to the test and scoring specifications as set out in the methodology. Subsequently, a blended learning training programme was developed for occupational therapists, which included an online module followed by a face-to-face training session. On conclusion of this phase, the newly developed sensory integration screening instrument was named the South African Sensory Integration Screening Instrument or SASISI.

6.3 RESULTS FOR PHASE TWO

The aim of Phase two of the study was to field test, refine and determine internal construct validity and clinical utility of the sensory integration screening instrument. The results for this phase will be discussed according to each of the three objectives.

6.3.1 Objective 1: To pilot test the screening instrument within low socio-economic environments.

Prior to the field-testing, a pilot testing was done to determine difficulties in administration and scoring of the SASISI.

6.3.1.1 Results of the pilot testing prior to assessing for internal construct validity

Six children were involved in the pilot testing of the SASISI. The three children from the high socio-economic environment had less difficulty in understanding the instructions and needed less demonstration, whilst the children from the low socio-economic environment needed more demonstration added to the verbal instructions. The difficulty levels of the activities were appropriate for all six activities and the children participated with ease. Table 6.13 provides feedback on the demographic information of each child and the administration difficulties experience by each child.

Table 6.13: Demographic information for the sample used during the pilot testing to determine difficulties with the sensory integration screening instrument.

Demographic information						Observations made			
	Gender	**Age**	**Grade**	**Home Language**	**SES**	**Clarity of instructions**	**Feasibility of the procedures**	**Ease of scoring**	**Language of instruction**
Child 1	Male	5 y 3 m	R	Afrikaans	High	Needed added demonstration for clay activity.	No problems observed.	Definition of scores for quality and motor movements not always clear.	No problems with verbal instructions.
Child 2	Female	6 y 6 m	1	English	High	No problems with instructions.	No problems observed.	Descriptions not detailed enough.	No problems with verbal instructions.
Child 3	Male	5 y 11 m	R	Afrikaans	High	No problems with instructions.	No problems observed.	Descriptions not detailed enough.	No problems with verbal instructions.
Child 4	Male	6 y 2 m	1	Zulu	Low	Instructions not clear for block and clay activity. Instructions were not clear to child.	Colouring in the full spider takes a very long time. Child slow to complete the task.	Descriptions not detailed enough. Needs specific observations for star jumps and cutting activity.	Difficulty with instructions of block and clay activity. Needed demonstration.
Child 5	Male	5 y 1 m	R	Xhosa	Low	Instructions not clear for finding block in the sand. Not clear to child that he needs to copy the administrator for star jumps.	Colouring in the full spider takes a very long time. Child slow to complete the task.	Descriptions not detailed enough. Needs specific observations for star jumps and walking heel-toe on a line.	Difficulty with instructions of block and clay activity. Needed demonstration.
Child 6	Female	6 y 8 m	1	Zulu	Low	Instructions not clear for block and clay activities. Not clear to the child that she needs to copy the star jumps.	Colouring in the full spider takes a very long time. Child slow to complete the task.	Descriptions not detailed enough. Needs specific observations for star jumps and walking heel-toe on a line.	Difficulty with instructions of block and clay activity. Needed demonstration.

6.3.1.2 Changes made to the SASISI following the pilot testing

Following the pilot study, some revision was necessary, and changes were made to the administration and scoring guidelines based on the feedback from the pilot study. Specific changes were made to clarify the instructions, changes to scoring guidelines and to individual activities for ease of administration and scoring.

6.3.1.2.1 Changes made to the clarity of the instructions and language used for instruction

The pilot testing revealed that the instructions were not always clear, and that the child's home language played a role in their understanding of the instructions. The language used for giving the instructions was a major difference between the two socio-economic groups. Although the instrument was designed in such a way that minimum language instructions were needed, the group from high socio-economic environments could understand and follow the English or Afrikaans instructions with ease. Although the group from low socio-economic environments had a basic understanding of English, they spoke either Zulu or Tswana and had some difficulties with the English instructions. This was expected, but what was not expected was the amount of verbal instructions that were still needed, despite using simple language and gestures or non-verbal cues. The six languages spoken mostly in Gauteng and North West Province are Zulu (22.7%), Xhosa (16%), Afrikaans (13.5%), English (9.6%), Setswana (8%) and Sesotho (7.6%) (Statistics South Africa, 2017). The instructions were clarified within the administration manual to assist administrators in explaining the instructions. A sheet with key terms for the verbal instructions was developed to assist the therapist with verbal instructions for children speaking isiZulu, isiXhosa, Sesotho and Setswana. As the standard instructions were kept short only key terms for the instructions were needed, for example telling the child to watch the administrator and copy your actions were translated into key terms, e.g. for isiZulu, watch me (qaphela) and you copy (uzama) (See Appendix I). The aim of this sheet was to provide the administrator with some key terms that could be used to clarify instructions if the child does not understand the instructions in English, or the physical demonstration.

6.3.1.2.2 Changes made to individual activities to improve feasibility for use

Four of the activities were feasible and did not require changes, but the clay activity and the spider cutting activity needed some changes for ease of administration and for saving time in the execution of the activity.

Clay activity: Initially children were asked to construct a clay shape based on verbal instruction only. The activity was changed to drawing a shape on the child's hand and asking them what the shape was. The child was told the name of the shape and they were asked to construct the shape. ***Spider cutting activity:*** The children from the low socio-economic environment took much longer in colouring in the spider's body. To shorten the activity the researcher changed the template so that the colouring in part of this task only included colouring in a few shapes that were drawn on the back of the spider's back.

6.3.1.2.3 Changes made to scoring guidelines and descriptors

The pilot study found that the description of scoring for items were interpreted with difficulty by the administrators and needed descriptions that are more detailed. The scoring guidelines were adapted to include descriptors that are more detailed for each score. More activity specific scoring guidelines were included and are reflected in Table 6.14

Table 6.14 Changed scoring definitions and explicit observations that need to be considered under the specific activities

	Assistance needed	**Quality & accuracy of task execution/product**	**Movements**
1	Unable to execute activity even with verbal/physical assistance.	Poor quality and severe difficulties with accuracy of task/product execution.	Severe difficulties with coordination, speed and control of movements.
2	Child needs verbal/physical assistance during all stages of the activity.	Poor quality and moderate difficulties with accuracy of task/product execution.	Moderate difficulties with coordination, speed and control of movements.
3	Child needs verbal/physical assistance once/twice during activity.	Poor quality that improves with practice and mild difficulties with accuracy of task/product execution.	Mild difficulties with coordination, speed and control of movements.
4	Can complete without assistance, with good quality.	Good quality execution. Speed and coordination.	No difficulties with movements. Good coordination, speed and control of movements.

Table 6.14 Changed scoring definitions and explicit observations that need to be considered under the specific activities - continue

	Assistance needed	Quality & accuracy of task execution/product	Movements
HEEL-TOE WALKING -			
	Walking on line – check placement of feet and whether they need a reminder. Does the child need reminders to keep their eyes closed?	Observe the child's ability to stay on the line while walking heel-toe.	Observe the child's ability to maintain their balance. Observe the coordination of movements.
STAR JUMPS			
	Is the child able to copy the star jumps or do they do their own version of the star jumps?	Observe the quality of movements.	Observe the movements when jumping with feet together. Observe the movements when jumping with feet and arms together.
BLOCK CONSTRUCTION			
	Does the child need assistance to find the blocks in the sand?	Observe the child while finding blocks in the sand. Observe the child when building block patterns.	Observe the child's movement when reaching and grasping blocks.
CLAY FORMS			
	Does the child need help with rolling balls and worms? Does the child need help with recognising shapes drawn on hands?	Rolling balls and worms. Feeling shapes drawn on hands.	Rolling balls and worms. Rolling with different hands.
SPIDER CUTTING			
	Does the child need assistance with colouring in? Does the child need assistance with cutting with scissors? Does the child need assistance with sticking/pasting the spider's legs? Does the child need assistance with sticking the string on the spider's body?	What is the quality of the colouring in? What is the quality or accuracy of the cutting with the scissors? What is the accuracy of sticking the items together to form the spider?	Does the child have difficulty with pencil skills? Does the child have difficulty with cutting with scissors?

6.3.1.2.4 Familiarity of equipment and materials and overall instrument use

The pilot study found the instrument was easy to use, with cost-effective and affordable equipment that is easily obtainable from shops and known to children from low socio-economic environments. All the children knew the equipment such as wooden blocks, sand, clay or playdough, colouring in pencils and scissors. Setup of all the equipment prior to the start of the assessment is needed to ensure smooth transition between subtests. This guideline was added to the test manual.

6.3.2 Objective 2: To establish internal construct validity of the sensory integration screening instrument

All the above changes were made in the administration manual (Appendix F) prior to the start of testing to determine the internal construct validity of the SASISI.

6.3.2.1 Demographic results for the sample

The sample was chosen from two provinces, namely Gauteng and North West Province. Within Gauteng, schools were chosen from the city of Johannesburg district, located in the townships of Soweto and Alexandra. The North West sample included the Dr Kenneth Kaunda district, and included a school from the Ikageng township from the town of Potchefstroom. Figure 6.8 provides information on where the provinces and townships are within South Africa.

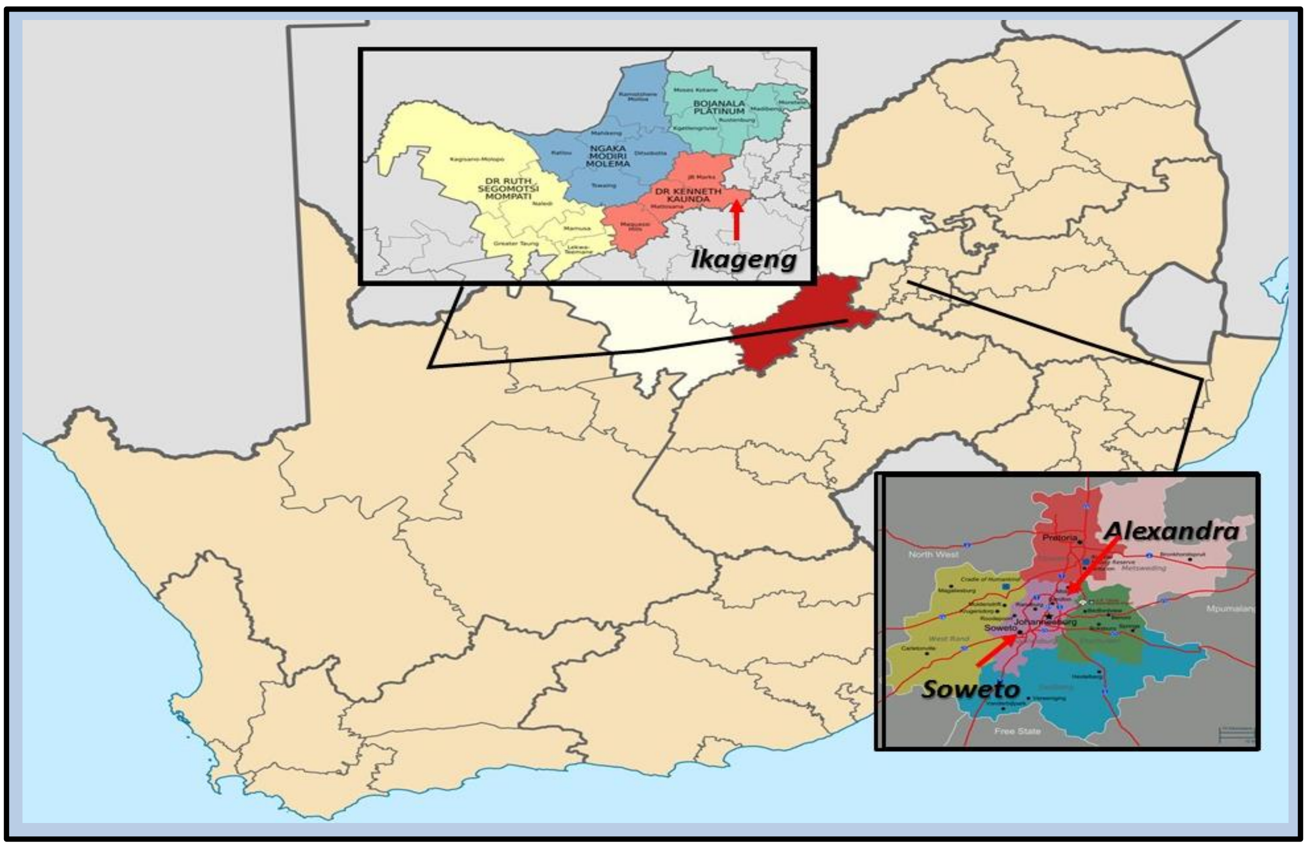


Figure 6.8: Visual representation of Gauteng and North-West province within the South African context

It is important to understand the context of each of these areas to assist the reader in making sense of the data. Table 6.15 provides a comparison of specific research sites for data collection and shows the differences between the areas where the children are living, the total population living within that area, as well as the population density for each of the three areas.

Table 6.15 Comparison of specific research sites for data collection

Area	Soweto	Alexandra	Potchefstroom
Urban/Rural*	Urban area	Urban area	Rural area
Area Size*	200.03 km^2 (77.23 sq. mi)	6.91 km (2.67 sq. miles)	17.71 km^2 (6.84 sq. mi)
Population total*	1 271 628	179,624 (400 000)	87,701
Population density*	6 357/km^2 (16 464,6/myl^2)	26,000/km^2 (67,000/sq. mi)	5,000/km^2 (13,000/sq. mi)
School learner population**	1554	1198	1225

* (Statistics South Africa, 2012a) ** (Department of Basic Education, 2014)

Soweto and Alexandra are townships within the Greater Johannesburg in Gauteng Province. Gauteng is the smallest province, yet 29% of the South African population lives in this area with a labour force from other provinces and surrounding countries (Hall and Sambu, 2017). Interestingly children equate to only 1/5 of this population. The school learner population shows the overall number of learners for 2014 for each of the specific schools.

Soweto context

Soweto is a township 15 km south-west of Johannesburg and lies next to the mining belt in the south of Johannesburg. The name Soweto comes from the apartheid era when it was known as the South Western Townships, where Black South Africans were relocated (Naidoo, 2014; Executive Mayor Johannesburg, 2008). The area has a population of approximately 1.3 million, which lives in an area of 200 km^2 in a mixture of shanty towns and brick houses (Statistics South Africa, 2012a). The office of the Executive Mayor Johannesburg (2008) however reports that it is believed these numbers are not accurate and that there are probably over 4 million inhabitants due to a large number of illegal immigrants. Soweto is frequently flooded with migrants from more rural parts of South Africa, as well as illegal immigrants looking for jobs and a better way of life (Executive Mayor Johannesburg, 2008). Figure 6.9 provides a visual representation of the living conditions in Soweto.

Despite improvements in living conditions, employment and tourism to the area, Soweto is still poverty stricken with a high prevalence of HIV/AIDS, violence, unemployment, unhygienic conditions and lack of resources, etc. (Naidoo, 2014).

Learner numbers in schools in Soweto are high and the primary school involved in the study had 1554 learners with over 40 children per class and only one educator.

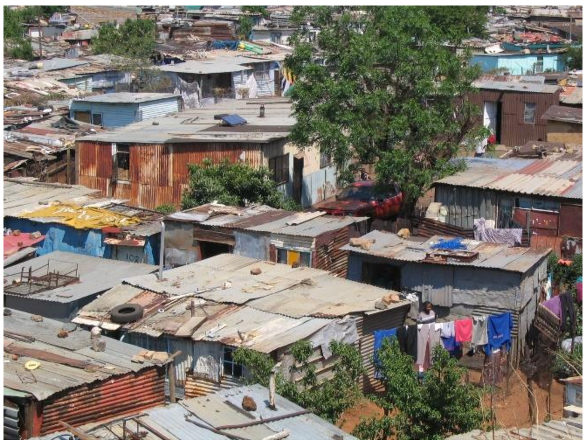


Photo reference: Neiljs (2011)	**Photo reference**: Wilson (2004)
Informal settlement within Soweto. Houses are small and built from zinc and very close together. There are areas in Soweto where housing conditions have improved over the years.	Basic services such as water are not always readily available and needs to be collected from a certain point that is not necessarily clean and healthy.

Figure 6.9: Visual representation of Soweto to provide context

Alexandra context

Alexandra township, one of the poorest townships in South Africa, was established in 1917 near to Sandton, one of the most affluent areas in Johannesburg (Onatu and Ogra, 2014). The population estimate for this area is 180 000, which is much smaller than Soweto, but the population density is such that they live in a small area of 6.91km^2, resulting in 26 000 people per km^2 (Statistics South Africa, 2012a). Figure 6.10 provides a visual representation of the living conditions in Alexandra. Due to the high density of the population, houses mostly consist of informal dwellings (shacks) that are very close together, small and with very little space for children to play. Poverty is very high and Statistics South Africa (2012a) found that 25.1% of the population in Alexandra have no income, compared to the 18.7% of Soweto and the 14.3% of Ikageng.

	
Photo reference: (City of Johannesburg Website, 2012)	**Photo reference:** http://assets.espn.go.com/photo/2010/0711 /soc_a_alexandra_township_shacks_576.jpg
Informal settlement within Alexandra. Houses are similar to those in Soweto but much closer together. Poverty is very high in this area.	The area is highly populated with very poor basic services, such as refuse removal, accessibility to toilets, water and electricity.

Figure 6.10: Visual representation of Alexandra to provide context

Ikageng/Potchefstroom context

Ikageng is a township near the town of Potchefstroom in North West Province of South Africa. Potchefstroom is a university town and the home of the North-West University. The township has around 87 000 people who live in an area of 17.7km^2 (Statistics South Africa, 2012a). Figure 6.11 provides a visual representation of the living conditions in Ikageng. Although there are areas consisting of informal shacks, 71.2% of the population live in housing that is more formal. Lower education levels seem to be prevalent in Ikageng, as 8% of the population have no education and the levels of attending high school or obtaining a matric is lower than in Alexandra and Soweto.

	
Photo reference: https://suedafrikachillz.wordpress.com/2013/08/10/besuch-bei-mosaik/	**Photo reference:** http://www.inventafrica.co.za/Stories/agentType/View/PropertyID/149
Informal settlement. Ikageng is in a more rural area and more space is available between houses. Basic services are however still problematic.	Ikageng has more brick houses on a small plot allowing for gardening where the children can play.

Figure 6.11: Visual representation of Ikageng/Potchefstroom to provide context

The sample used for the field-testing consisted of 99 children from Soweto, 44 children from Alexandra and 57 children from Ikageng. The variation between male and female were evenly spread (see Table 6.14). The school in Soweto had more learners and therefore more children in grade R and grade 1 available for participation.

Table 6.16 Gender distribution for internal construct validity sample population (n=200)

	Male n (%)	**Female n (%)**	**TOTAL**
Soweto (n=99)	42 (42%)	57 (58%)	99 (100%)
Alexandra (n=44)	23 (52%)	21 (48%)	44 (100%)
Potchefstroom (n=57)	22 (39%)	35 (61%)	57 (100%)

The gender distribution shows that the population was evenly distributed between male and female participants as can be seen in Table 6.16. Slightly more males (26%) were included in the Alexandra group and more females (61%) in the Potchefstroom group (see Table 6.16). Table 6.17 showed that in terms of age groups, 152 children in the group were older than 6 years 0 months and only 48 children were between 5 years 0 months and 5 years 11 months.

Table 6.17 Age and gender distribution of internal construct validity sample population (n=200)

	Males n = 87	Female n = 113	TOTAL n = 200
Group 1 **5 years 0 months to 5 years 6 months**	5 (5%)	6 (5%)	**11 (5%)**
Group 2 **5 years 7 months to 5 years 11 months**	11 (13%)	26 (23%)	**37 (19%)**
Group 3 **6 years 0 months to 6 years 6 months**	37 (43%)	39 (35%)	**76 (38%)**
Group 4 **6 years 7 months to 6 years 11 months**	34 (39%)	42 (37%)	**76 (38%)**

South Africa is a diverse country with eleven official languages (Statistics South Africa, 2017). Different languages are spoken in different areas of the country and may have an influence on the instructions used within a test. Figure 6.12 shows that within this population, it was found that Setswana is the preferred language in rural Potchefstroom (63%), with 28% Sesotho and 9% isiXhosa speaking children. Children in Alexandra also spoke Setswana (43%), as well as isiZulu (39%), Sesotho (11%) and isiXhosa (7%). In Soweto, it was found that 53% of the children spoke isiZulu, 25% isiXhosa, 17% Setswana and 7% spoke Sesotho.

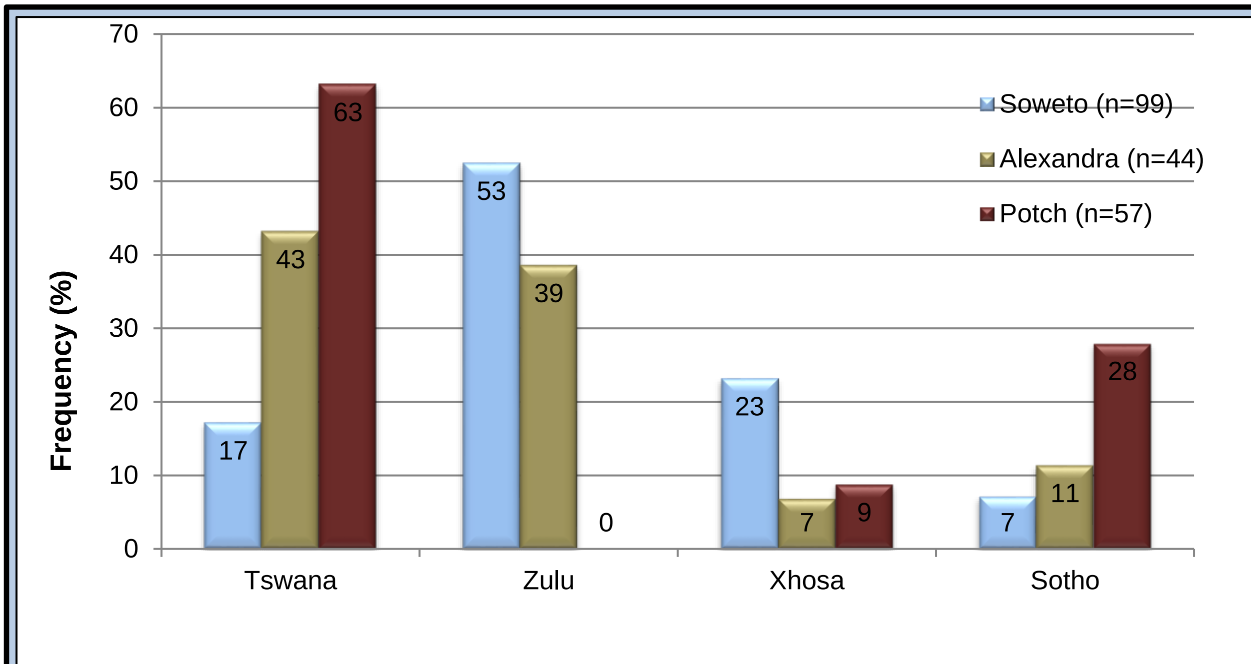


Figure 6.12 Percentage of home languages spoken within the different areas of testing

Table 6.18 shows a comparison of the family structure and social status between research sites. In all three areas, most of the children lived with their mothers as the primary caregivers. Only 21.9% of children in Soweto lived with both parents, 20.6% in Alexandra and 38.1% in Potchefstroom. The mother was the main provider for the family in all three areas with the highest percentage in Alexandra (55.9%), followed by Potchefstroom (50%) and Soweto (48.6%). More fathers in Soweto (28.1%) and Potchefstroom (23.8%) also contributed to the income, compared to only 5.9% of fathers in Alexandra. Grandparents were also a big contributor to the household income in Alexandra (23.5%) and Potchefstroom (19%).

Table 6.18 Comparison of family structure and social status between research sites

Family structure and social status	SOWETO n = 32	ALEXANDRA n = 34	POTCHEFSTROOM n = 42
Primary caregiver	**n (%)**	**n (%)**	**n (%)**
Mother	19 (59.4%)	19 (55.9%)	20 (47.6%)
Both parents	7 (21.9%)	7 (20.6%)	16 (38.1%)
Grandmother	4 (12.5%)	8 (23.5%)	4 (9.5%)
Grandfather	0 (0.0%)	0 (0.0%)	0 (0.0%)
Aunt/Uncle	1 (3.1%)	0 (0.0%)	1 (2.4%)
Siblings	0 (0.0%)	0 (0.0%)	0 (0.0%)
Father	1 (3.1%)	0 (0.0%)	1 (2.4%)
Other	0 (0.0%)	0 (0.0%)	0 (0.0%)
Marital status mother	**n (%)**	**n (%)**	**n (%)**
Never married & not living with a partner	14 (43.8%)	19 (55.9%)	20 (47.6%)
Never married & living with a partner	10 (31.2%)	8 (23.5%)	9 (21.4%)
Married & not living with partner	4 (12.5%)	4 (11.8%)	4 (9.6%)
Married and living with partner	4 (12.5%)	3 (8.8%)	9 (21.4%)
Education Mother	**n (%)**	**n (%)**	**n (%)**
Less than grade 5	0 (0.0%)	0 (0.0%)	5 (11.9%)
Primary school (Grade 6 & 7)	0 (0.0%)	1 (2.9%)	4 (9.5%)
Junior secondary (Grade 8 & 9)	5 (15.6%)	5 (14.7%)	6 (14.3%)
Senior secondary (Grade 10 & 11)	19 (59.4%)	15 (44.1%)	19 (45.2%)
Matric/Vocational training	8 (25.0%)	11 (32.4%)	7 (16.7%)
College/University	0 (0.0%)	2 (5.9 %)	1 (2.4%)
Other training	0 (0.0%)	0 (0.0%)	0 (0.0%)
Income provider	**n (%)**	**n (%)**	**n (%)**
Mother	17 (48.6%)	19 (55.9%)	21 (50.0%)
Father	9 (28.1%)	2 (5.9%)	10 (23.8%)
Grandparents	3 (9.4%)	8 (23.5%)	8 (19.0%)
State pension	2 (6.3%)	1 (2.9%)	2 (4.8%)
Other Family (sibling/aunt/uncle)	1 (3.1%)	4 (11.8%)	1 (2.4%)

The level of the mother's education plays a detrimental role in the child's development (Abubakar et. al., 2010). In Soweto, the mothers' education was found to be at junior secondary level or above. Mother's from Alexandra also attained education above junior secondary level, with one mother having only primary school education. In Potchefstroom, the mothers' education ranged from less than grade 5 to college level with the average level of education on a secondary level similar to those of Soweto or Alexandra.

Table 6.19 Comparison of household environments between research sites

Household environments	**SOWETO n = 32**	**ALEXANDRA n = 34**	**POTCHEFSTROOM n = 42**
Type of housing	n (%)	n (%)	n (%)
Homeless	0 (0.0%)	2 (6.5%)	0 (0.0%)
Shack/informal housing	18 (56.2%)	3 (9.7%)	22 (52.4%)
Hostel	1 (3.1%)	3 (3.2%)	0 (0.0%)
Room/garage	2 (6.3%)	10 (32.2%)	1 (2.4%)
Flat	1 (3.1%)	1 (3.2%)	3 (7.1%)
Home share with another family	2 (6.3%)	4 (12.9%)	5 (11.9%)
Own home	8 (25.0%)	10 (32.3%)	11 (26.2%)
Amenities available			
Average number of rooms in dwelling	1-2 rooms	1-2 rooms	2 – 3 rooms
Average number of people living in dwelling	5,7	5.7	6.1
% of Homes with separate kitchen	34.4%	50%	76.2%
% of Homes with separate bathroom	40.6%	47%	57%
% of Homes with toilet inside house	21.9%	32.4%	33.3%
% of Homes own a refrigerator	84.4%	91%	78.6%
% of Homes own a television	100%	94%	88.1%
% of Homes own a DVD player	15.6%	23.5%	23.8%
% of Homes own a washing machine	12.5%	47.1%	66.7%
% of Homes own a microwave oven	40.6%	70.6%	69.0%
% of families own a telephone	46.9%	44%	40.5%
% of Families own a car	18.8%	20.6%	11.9%
Caregiver perception of safety of neighbourhood	**%**	**%**	**%**
% of caregivers feel neighbourhood safe	68.8%	58.8%	59.5%
% of caregiver who worry often/all the time about child safety outside house.	62.5%	50%	33.3%

Table 6.19 shows the comparison between household environments from the research sites. Types of housing varied considerably between the three research sites, but in Soweto and Potchefstroom, most participants lived in informal housing.

Informal housing consist of shelters or dwellings built from cheap materials such as corrugated iron sheets, wood or plastic (Hunter and Posel, 2012). In Soweto, more than half of the sample population resided in informal housing with an average of one to two rooms and an average of 5.7 people residing per house. Only 34.4% of the sample had a separate kitchen, 40.5% had a separate bathroom and only 21.9% had an inside toilet. Luxury items such as a DVD player (15.6%), washing machine (12.5%) and a car (18.8%) were owned by only a few of the families. In Alexandra, the families stayed in a range of housing with 32.2% living in a room or garage with an average of one to two rooms and 32.2% lived in their own homes; two of the participants were found to be homeless with no specific dwelling in which to live. A ratio of 5.7 people was found to be living in a dwelling, which was similar to Soweto. A higher percentage of households had separate kitchens (50%), bathrooms (47%) and an inside toilet (32.4%). Families also had higher percentages of luxury items such as a washing machine (47.1%), microwave oven (70.6%) and a car (20.6%). In Potchefstroom, 52.4% of the sample lived in informal housing and 26.2% lived in their own homes. The average number of rooms of the dwellings (2-3 rooms) were more than in Soweto and Alexandra, but more inhabitants (6.1) lived in a dwelling. In Potchefstroom more houses were found to have a separate kitchen (76.2%), a separate bathroom (57%) and an inside toilet (33.3%).
Again, luxury items such as a DVD player (23.8%) and a car (11.9%) were owned by only a few of the families. More families had access to a washing machine (66.7%) and a microwave oven (69%). Interestingly, less than half of the population had access to a telephone in Soweto (46.9%), Alexandra (44%) and Potchefstroom (40.5%). Only 20% or less of the families owned a car suggesting they have to use public transport to get to school and work. Although more than half of parents perceived their neighbourhood as safe, they did indicate they feel worried about their child's safety outside the house; this was highest in Soweto (62.5%) compared to Alexandra (50%) and Potchefstroom (33.3%).

The teacher questionnaire (Appendix R) provided information on the child's level of functioning in the classroom and in the playground that could be an indication of sensory integration difficulties. Table 6.20 gives a visual representation of the percentage of children that functioned on each level for classroom behaviours. A score of four and above indicated a level of classroom functioning that is on par with children of a similar age or even better. A score of three and below indicated that the child experienced more difficulty than other children of the same age and needed more assistance. The data for the questionnaire were analysed in terms of the percentage of children obtaining a score on each level of scoring. The aim of the teacher questionnaire was to investigate the overall functioning of the child population for classroom behaviour.

Table 6.20: Percentage (%) of sample population's, level of functioning, for classroom behaviours, according to the teachers

SCORE	1	2	3	4	5	
DESCRIPTION OF LEVEL OF FUNCTIONING	Finds it much more difficult than other children of the same age. Needs much more physical assistance and prompting than others.	Finds it more difficult than other children of the same age. Needs more physical assistance, more than others.	Finds it slightly more difficult than other children of the same age. Needs more verbal prompting than others.	The same as other children of the same age.	Performs better than other children of the same age.	TOTAL
Initiation of a task	4.8	11.4	20	47.6	16.2	100
Completion of tasks	2.8	18.7	23.3	42.1	13.1	100
Problem solving	4.7	17.9	20.8	43.4	13.2	100
Organisation of work	2.9	6.7	25	51	14.4	100
Work speed	4.6	20.4	19.4	42.6	13	100
Follow of instructions	0.9	14.2	26.4	44.3	14.2	100
Concentration in class	5.8	15.4	27.8	37.5	13.5	100
Turn taking	4.1	6.8	24.7	61.7	2.7	100
Interaction with peers	2.8	3.7	18.5	59.3	15.7	100
Fine motor skills	2.9	10.6	28.8	48.1	9.6	100
Gross motor skills	1	5.7	24.7	52.4	16.2	100
Balance	0.9	1.9	26.4	56.5	14.2	100
Coordination	0.9	8.4	22.4	53.3	15	100
Manages emotions	0.9	7.5	18.9	66	6.7	100
Behaviour	1	9.3	24.7	53.6	11.4	100
Average for sample	**2.7**	**10.6**	**23.5**	**50.6**	**12.6**	**100**

* All scores are recorded in %

Within this sample, 50.6% of the children functioned on the same level within the classroom as other children (obtaining a score of 4), and 12.6 % of the sample obtained a score of 5, indicating they performed better than other children of the same age. It was found that 36.8 % of the sample obtained a score of 3, 23.5% a score of 2, 10.6% and 2.7% a score of 1, indicating possible sensory integration difficulties. When investigating specific behaviours, it was found the sample obtained a score of 3 or less for completion of tasks (44.8%), problem solving (43.4%), work speed (44.4%), following of instructions (41.5%) concentration in class (49%) and fine motor skills (42.3%). More than 60% of the sample did similar or better than children of their age on initiation of a task (63.8%), organisation of work (65.4%), turn taking 6.4%), interaction with peers (75%), gross motor skills 68.6), balance (70.7%), coordination (68.3%), managing emotions (72.7%) and behaviour (65%).

6.3.2.2 Results of the Rasch analysis to establish internal construct validity

Each domain was analysed in a number of rounds to determine fit to the Rasch model. The results will be discussed in the order of analysis, e.g. threshold ordering, item and person fit, local independence, differential item functioning, reliability and uni-dimensionality. Table 6.21 is a summary of the fit of the data to the Rasch requirements for all nine domains. Numbers and text in red show fit to the Rasch model.

Table 6.21: Summary statistics for the Rasch analysis

Test	Threshold ordering	Fit statistic			Individual item fit	Subtests	Local dependency	PSI	Uni-dimen-sionalty
		Chi-square (>0.05)	Mean Item Fit residual (0.00)	Mean Item Fit residual SD (1.00 SD)	±2.5		(<0.30)	(>0.85)	(<5%) CI
Sensory perception	Before sub testing All items ordered	0.00	0.55	0.84 SD	All subtests fitting	8 subtests	No local dependency	0.77	8% 0.050 – 0.110
Postural Control	All items ordered before subtests	0.00	0.56	0.89 SD	All subtests fitting	5 subtests	No local dependency	0.77	6% 0.03-0.09
Bilateral Integration & sequencing	All items ordered before subtests	**0.08***	0.53	1.48 SD	All subtests fitting	6 subtests	No local dependency	0.70	6.53% 0.035-0.096
Praxis	All items ordered	0.00	0.64	1.67 SD	Subtest 1 (3.370) Subtest 4 (2.778)	9 subtests	No local dependency	***0.84***	11.1% 0.081-0.143
Object Handling	All items ordered	***0.49****	-0.05	0.76 SD	All subtests fitting	5 Subtests	No local dependency	0.76	**2.5%** -0.005 – 0.055
Visual form and space	All items ordered	0.00	0.31	1.63 SD	Subtest 3 (2.818) Subtest 7 (3.074)	12 subtests	No local dependency	***0.83***	10.05% 0.070-0.131
Sensory reactivity	All items ordered	0.00	-0.13	1.38 SD	All items fitting	No sub testing	No local dependency	0.53	**1.50%** -0.015-0.045
Organisation of space and environment	All items ordered	0.00	-0.14	1.11 SD	Items 1 (3.844) Item 4 (-2.687)	No sub testing	No local dependency	0.69	**0.53%** -0.026- 0.036
Organisation of self and behaviour	All items ordered	0.00	-0.22	1.23 SD	All items fitting	No sub testing	See table residual correlations	***0.81***	**4%**

6.3.2.2.1 Sensory perception

The sensory perception domain was subjected to four rounds of analysis in an attempt to achieve fit to the Rasch model. Firstly, the **threshold ordering** of the response categories for the subtests were investigated to determine if the responses consistently measured the latent trait and sensory perception. The screening instrument had four response categories (0123) to discriminate between the person's ability to execute a task. In the first round of analysis one, it was determined that items 1 to 7 had disordered thresholds, meaning that the response categories were not working as expected. Andrich (1978) suggested that scores might be collapsed to get data that are more accurate. The categories for items 1 to 7 1 and 2 and 3 and 4 were collapsed, but the thresholds were still disordered for items 1 to 7, which were subsequently deleted during the second round of analysis. The third round of analysis found items 35, 38 and 54 to have disordered thresholds and item 38 scores 1 and 2 and 3 and 4 were collapsed, and in item 54 scores 1 and 2 were collapsed. Further analysis indicated that this still did not order the thresholds and items 35, 38 and 54 were therefore deleted. Analysis four indicated that all thresholds were ordered. Table 6.22 provides information on threshold ordering and the ultimate action that was taken to order the thresholds.

Table 6.22: Sensory perception: Threshold ordering per analysis

Item no	Item name	Number of analysis	Threshold ordering	Number of analysis	Final action
1	Determine where garment is on his/her body through using touch.	1	0011	2	Deleted
2	Knowledge of where body/body parts are in space.	1	0011	2	Deleted
3	Postural movements and changes during the activity effective.	1	0011	2	Deleted
4	Balance and equilibrium reactions while taking garment off.	1	0011	2	Deleted
5	Balance and equilibrium while putting the shirt on.	1	0011	2	Deleted
6	Knowledge of where body/body parts are in space.	1	0011	2	Deleted
7	Postural movements and changes during the activity effective.	1	0011	2	Deleted
35	SAND Ability to keep eyes closed.	3	0011	4	Deleted
38	SAND Discrimination of blocks in sand.	3	0011	4	Deleted
54	DRAWING Ability to keep hands flat on the table.	3	0112	4	Deleted

Item-person fit investigated the responses of individuals to each of the items and by the final analysis; eighteen items were deleted, as they did not fit the model.

A mean item fit residual of 0.00 and a mean item fit residual SD of 1 indicate a strong fit to the Rasch model (Pallant and Tennant, 2007). The final analysis for the sensory perception domain showed overall summary fit statistics as a mean item-fit residual score of 0.55 (SD= 0.84). Individual item-fit analysis showed residual item-fit scores for 36 (2.65), 42 (3.52), 55 (3.67), 57 (3.67), 62 (3.91), 64 (3.06) and 66 (3.46) that fell outside the range of ± 2.5, indicating these items did not discriminate between items. An item that misfit can be deleted in an attempt to improve internal construct validity (Tennant and Conaghan, 2007). Clinical consideration of the items resulted in the deletion of items 42, 62, 64 whereas items 36, 55, 57 and 66 were retained as they provided valuable clinical information.

The person-item map, Figure 6.13, shows the person ability distribution compared to the item difficulty distribution for the sensory perception domain. The findings show a mean person location of 0.75 (SD = 0.26), compared to an item location of 0.0 (SD = 0.59) indicating a poor match between item difficulty and the person ability for sensory perception. Figure 6.13 shows that categories for several items were not endorsed and the categories were not able to discriminate between the item difficulty and the sample's ability.

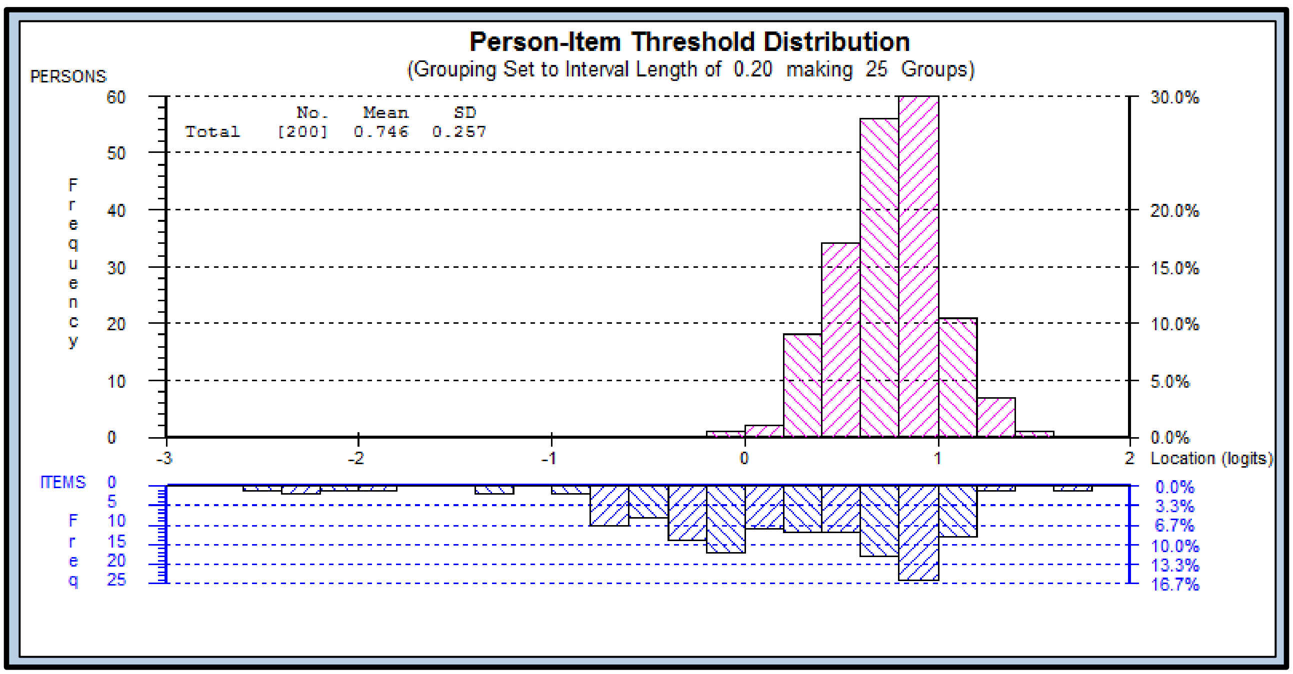


Figure 6.13: Sensory perception: Person-item threshold distribution map with persons (red) and items (blue) locations.

Chi square statistics provide further information on the item-trait (Hagquist et. al., 2009). The Chi-square value indicates the overall difference between the real data and the expected values as set out by the Rasch model.

A Chi-square less than 0.05, indicates a poor fit to the Rasch model, as there is a significant difference between the data and the requirements of the Rasch model. Final analysis indicated a Chi-square value of p = 0.00 indicating a significant difference between the data and the requirements of the Rasch model

Following the investigations of person-item fit, ***local independence*** was determined by analysing the inter-item correlations to ensure that items did not relate to each other. A correlation of > 0.3 show strong local dependence. Analysis of residual correlations generated nine subtests, but as subtests one and two correlated, they were combined to finally end up with eight subtests. Table 6.23 illustrates that no local dependency was found in the final analyses, as all subtests obtained a residual correlation score of less than 0.30. This means there are no items in the subtests that give a cue to other items and thus inflate the score of that subtest.

Table 6.23: Sensory perception: Local dependency (>0.30) - residual correlations

Sub test	ST01	ST02	ST03	ST04	ST05	ST06	ST07	ST08
ST01	1							
ST02	-0.383	1						
ST03	-0.317	-0.178	1					
ST04	-0.098	-0.247	0.186	1				
ST05	-0.300	-0.485	0.019	0.021	1			
ST06	-0.339	-0.178	0.090	0.054	0.055	1		
ST07	-0.044	-0.282	0.111	0.090	0.162	-0.102	1	
ST08	-0.302	-0.061	0.187	0.090	0.028	0.004	0.076	1

Differential item functioning determines whether subgroups within the sample respond different to an item and may have advantages or disadvantages in comparison to other subgroups, e.g. bias in terms of gender. Table 6.24 shows that no significant bias was found between male and female children for the subtests.

Table 6.24: Sensory perception: differential item functioning for gender (p > 0.05)

Item	Male	Female	DF	Probability P > 0.05
ST01	1.89	2.19	1	0.14
ST02	3.33	3.86	1	0.05
ST03	0.08	0.08	1	0.77
ST04	2.74	4.77	1	0.03
ST05	0.02	0.02	1	0.90
ST06	0.10	0.11	1	0.75
ST07	0.63	0.69	1	0.41
ST08	0.03	0.03	1	0.86

Reliability is a critical component of psychometric analysis of data as it indicates if the instrument will obtain related results at various times and within different samples. Internal consistency (a component of reliability) that is equivalent to a Cronbach alpha is determined by the ***person separation index*** (PSI) in the Rasch analysis. A PSI of > 0.85 is an acceptable score to establish internal consistency. The person separation index of the sensory perception domain for the screening instrument was $\alpha = 0.77$.

An equating t-test was done, and ***uni-dimensionality*** was found to be > 10%. A residual correlation indicated that subtests one and two correlated, so these two subtests were combined to form one subtest and subsequently uni-dimensionality improved to 8%. Uni-dimensionality was not achieved as the sensory perception domain showed significant differences between the positive and negative correlated groups and 8% fell outside the recommended criteria of 5%. Binomial testing, however, showed a 0.05 lower confidence interval, which is still within the expected range of ± 2.5. This means that it will be legitimate to sum the subtests to obtain a total score.

In summary, the Rasch analysis of the data for the sensory perception domain did not fit the Rasch model as the domain failed to adhere to the criteria for uni-dimensionality. The mean item-fit residual score of 0.55 (SD = 0.84) needed to be 0.0 (SD = 1) to fit the model with a significant Chi-square of $p = 0.0$ instead of a Chi-square >0.05. No local dependency or differential item functioning for gender were found. Uni-dimensionality of 8% was higher than the expected 5%.

6.3.2.2.2 Postural ocular control

The postural ocular control domain was subjected to four rounds of analysis to determine fit to the Rasch model. The screening instrument had four response categories and all ***thresholds*** were ordered before sub-testing. In analysis one it was determined that the responses for items 1, 2, 4, 8, 9, 10, 45, and 46 needed to be collapsed to improve category thresholds (see Table 6.25). Response categories for all the other items were kept the same. Overall fit did not improve with ordering the thresholds and these items were eventually deleted.

Table 6.25 Postural ocular control: Threshold ordering per analysis

Item no	Item name	Number of analysis	Threshold ordering	Number of analysis	Ultimate action
1	TAKE OFF Knowledge of where body/body parts are in space.	1	0012	2	Deleted
2	TAKE OFF Postural movements and changes during the activity effective.	1	0012	2	Deleted
4	TAKE OFF Balance and equilibrium reactions while taking garment off.	1	0012	2	Deleted
8	PUT ON Balance and equilibrium while putting the shirt on.	1	0012	2	Deleted
9	PUT ON Knowledge of where body/body parts are in space.	1	0012	2	Deleted
10	PUT ON Postural movements and changes during the activity effective.	1	0012	2	Deleted
45	Ability to keep hands flat on the table.	1	0112	2	Deleted
46	Overall Motor coordination.	1	0011 (yes/no)	2	Deleted

The final analysis for postural ocular control showed overall summary fit statistics as a mean item-fit residual score of 0.56 (SD= 0.89) compared to an ideal score of 0 (SD = 1). Individual item-fit analysis showed residual item-fit scores for all items within the range of ± 2.5. ***The person-item threshold distribution map***, Figure 6.12, shows the person ability distribution compared to the item difficulty distribution for the postural ocular domain. The findings show a mean person location of 1.01 (SD = 0.35), compared to an item location of 0.0 (SD = 0.68) indicating a poor match between item difficulty and the person ability for postural ocular control.

Figure 6.14 shows that categories for several items were not endorsed and the categories were not able to discriminate between the item difficulty and the sample's ability.

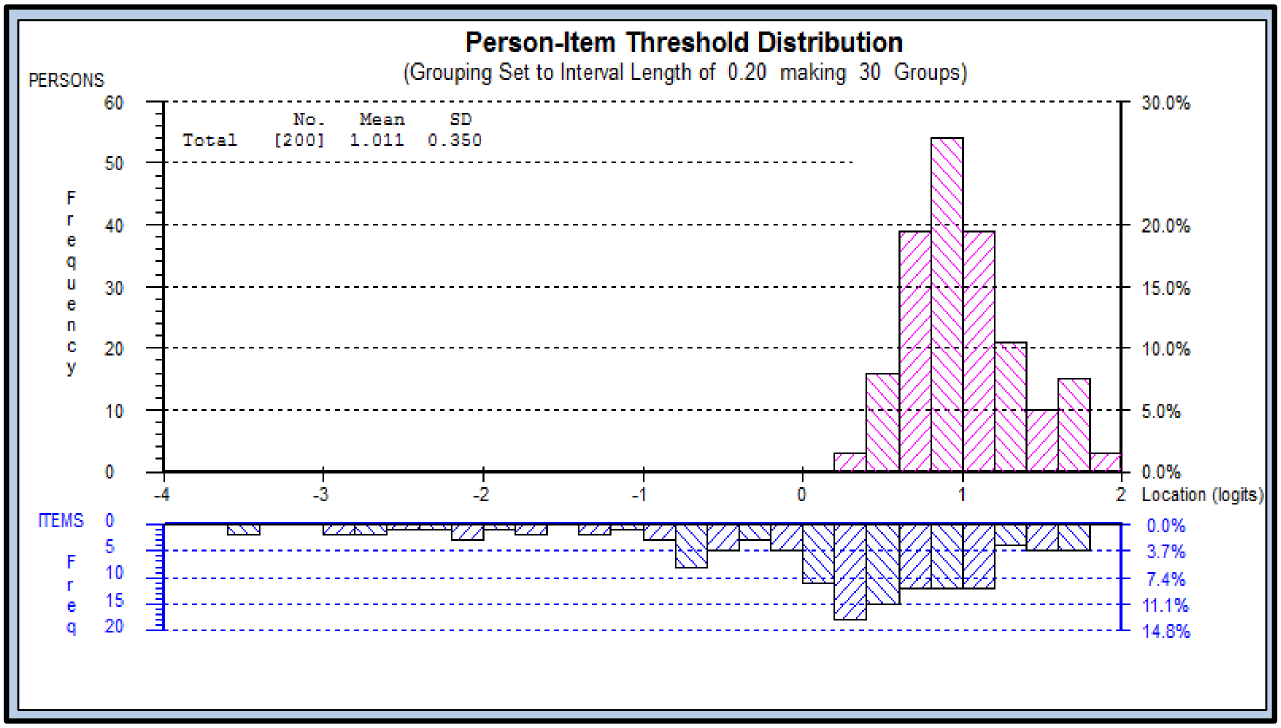


Figure 6.14: Postural ocular control: Person-item threshold distribution map with persons (red) and items (blue) locations

Final analysis indicated that the postural ocular control domain had a ***Chi-square*** of p = 0.00, showing there was a significant difference between the data and the requirements of the Rasch model. This is an indication that the data did not fit the Rasch model as required.

Residual correlation analysis found that subtest 4, with subtest 2 and 3, resulted in the deletion of items 15, 16, 17, 18, 34, 37, and 51. Further analysis of residual correlations showed five subtests, as displayed in Table 6.26. No ***local dependency*** was found as all residual thresholds were below 0.30.

Table 6.26 Postural ocular control: local dependency (<0.30) residual correlations

Item	ST01	ST02	ST03	ST04	ST05	ST06
ST01	1					
ST02	0.018	1				
ST03	-0.196	0.149	1			
ST04	-0.204	-0.344	-0.411	1		
ST05	-0.058	-0.136	-0.330	-0.431	1	
ST06	-0.089	0.004	-0.247	-0.237	0.125	1

Differential item functioning for gender showed no significant bias between male and female children for the subtests, as can be seen in Table 6.27. It was found that subtest six, which involved the colouring in and folding of the spiders and the spider's legs, was easier for girls than boys. No significant bias was found. It was also found that the younger age groups performed more erratic in all the subtests than the older children did, yet no significant differences could be found.

Table 6.27 Postural ocular control: differential item functioning for gender

Item	Male	Female	DF	Probability P > 0.05
ST01	2.42	2.48	1	0.12
ST02	0.14	0.21	1	0.64
ST03	0.17	0.18	1	0.67
ST04	1.07	1.10	1	0.30
ST05	0.37	0.36	1	0.55
ST06	2.04	2.60	1	0.11

A final ***person separation index*** off 0.77 was obtained, which was lower than the required 0.85 and indicates that internal consistency was not yet obtained.

An equating t-test was done to determine **uni-dimensionality,** which was found to be 6%; this is above the required minimum of 5%. Binomial testing, however, showed a 0.03 lower confidence interval that allows for the raw scores to be totalled.

In summary, the Rasch analysis of the data for the postural ocular domain did not fit the Rasch model as the domain failed to adhere to the criteria for uni-dimensionality. The mean item-fit residual score of 0.56 (SD = 0.89) needed to be 0.0 (SD = 1) to fit the model with a Chi-square of p >0.05, whereas the Chi-square for the postural ocular domain was p = 0.00.

No local dependency or differential item functioning for gender were found. Uni-dimensionality of 8% was higher than the expected < 5% and thus did not fit the Rasch model.

6.3.2.2.3 Bilateral integration and sequencing

The bilateral integration and sequencing domain was subjected to six rounds of analysis in an attempt to achieve fit to the Rasch model. Firstly, the **threshold ordering** of the response categories for the subtests were investigated to determine if the responses consistently measured the latent trait, bilateral integration and sequencing. The screening instrument had four response categories (0, 1, 2, 3) to discriminate between the person's ability to execute a task.

Threshold ordering indicated that scores for items 23, 24 and 36 needed to be collapsed as described in Table 6.28. This did not improve overall fit therefore; items were retained for clinical purposes.

Table 6.28 Bilateral integration and sequencing: Threshold ordering per analysis

Item no	Item name	Number of analysis	Threshold ordering	Number of analysis	Ultimate action
23	SAND Hand dominance/consistent hand use.	1	0112	3	Retained for clinical purposes
24	SAND Using both hands for finding blocks.	1	0022 Yes/no	3	
36	FOLD Coordinated movements of hand and fingers.	1	0112	3	

Item-fit analysis initially found items 14, 15, 19, 20 and 21 to misfit, with overfit for items 24 and 26. An extreme person was also found for child number 70, but once this data were taken out the fit of items improved. A mean item fit residual score for sensory perception showed a score of 0.53 (SD= 1.48). ***The person-item map***, Figure 6.13, shows the person ability distribution compared to the item difficulty distribution for the bilateral integration and sequencing domain. The findings illustrated a mean person location of 1.29 (SD = 0.32), compared to an item location of 0.0 (SD = 1.03) indicating a poor match between item difficulty and the person ability for sensory perception. Figure 6.15 shows that categories for several items were not endorsed and the categories were not able to discriminate between the item difficulty and the sample's ability.

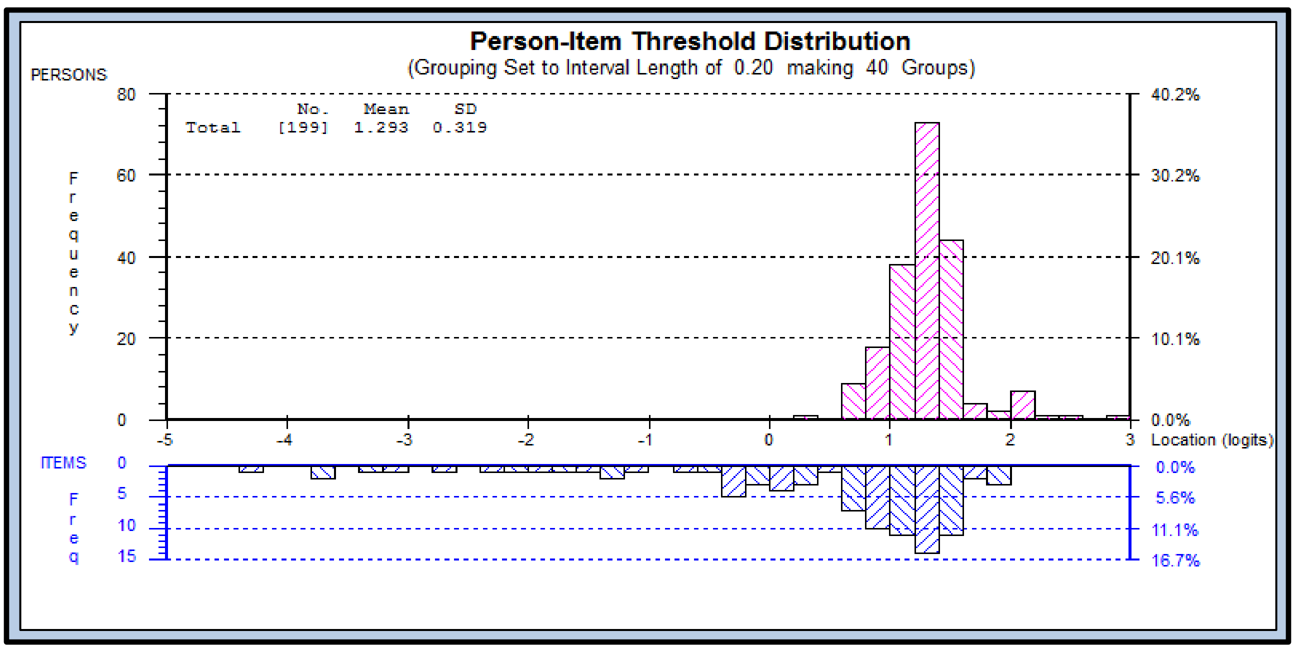


Figure 6.15: Bilateral integration and sequencing: Person-item threshold distribution map with persons (red) and items (blue) locations

Chi-square statistics provide further information on the item-trait. Final analysis indicated a Chi-square value of p = 0.08 showing no significant difference between the data and the requirements of the Rasch model.

Analysis four investigated ***residual correlations*** by grouping items together to eliminate further misfits, and items 1, 25, 26 and 38 were deleted as they were found to be unnecessary items. An item that misfits can be deleted in an attempt to improve internal construct validity (Tennant and Conaghan, 2007). The initial sub-testing generated seven subtests but subtest six and seven correlated and were combined to form one subtest. Analysis six was done and items 2 to 5, 27, 28, 29, 30, 31 and 33 were deleted to further improve the Chi-square and resulted in a final Chi-square of p = 0.81 and five subgroups. No local dependency was found, as can be seen in Table 6.29 as all scores are below 0.30.

Table 6.29: Bilateral integration and sequencing: Local dependency (>0.3) - residual correlations

Item	ST01	ST02	ST03	ST04	ST05	ST06
ST01	1					
ST02	0.080	1				
ST03	-0.339	-0.487	1			
ST04	0.072	-0.059	-0.243	1		
ST05	0.083	-0.089	-0.546	0.046	1	
ST06	0.219	0.152	-0.599	-0.003	0.053	1

Differential item functioning for gender, as seen in Table 6.30, showed no significant bias between male and female students for the subtests.

Table 6.30: Bilateral integration and sequencing: differential item functioning for gender

Item	Male	Female	DF	Probability P > 0.05
ST01	0.28	0.30	1	0.59
ST02	5.35	6.26	1	0.01
ST03	0.30	0.49	1	0.49
ST04	0.13	0.13	1	0.72
ST05	0.30	0.29	1	0.59
ST06	1.07	1.21	1	0.27

A final **person separation index** of 0.70 was obtained, which was lower than the required 0.85 and indicates that despite fitting the Rasch model, this sample could not be separated into high and low performers. Internal consistency was not yet obtained.

Uni-dimensionality was not achieved as the score of 6.53% fell outside the recommended criteria of 5%. Binomial testing, however, showed a 0.035 lower confidence interval, which means it would be legitimate to sum the subtests to obtain a total score.

In summary, the Rasch analysis of the data for the bilateral integration and sequencing domain did not fit the Rasch model as the domain failed to adhere to all the criteria. The final analysis indicated that all thresholds were ordered, and the mean item-fit residual score did not fit the model as the mean of 0.53 (SD = 1.48) needs to be 0.0 (SD = 1) or closer. A Chi-square of p = 0.08 indicated fit to the model as the Chi-square was more than 0.05.

No local dependency or differential item functioning for gender were found, however despite a Chi-square that fit the model, uni-dimensionality of 8% was higher than the expected 5%.

6.3.2.2.4 Praxis

The praxis component was subjected to two rounds of analysis to determine fit to the Rasch model. The praxis domain was subjected to four rounds of analysis in an attempt to achieve fit to the Rasch model. Firstly, the **threshold ordering** of the response categories for the subtests were investigated to determine if the responses consistently measured the latent trait, praxis. Threshold mapping indicated that items 6, 36, 66, 67 and 70 needed to be rescored to order the categories, as seen in Table 6.31.

Table 6.31 Praxis: Threshold ordering per analysis

Item no	Item name	Number of analysis	Threshold ordering	Number of analysis	Ultimate action
6	Put T-shirt on with label at the back.	1	0122	2	Deleted
36	PATTERNS Complete pattern 1 correctly within time.	1	0112	2	Deleted
66	FOLDING Coordinated movements of hand and fingers.	1	0112	2	Deleted
67	PASTING Opening & closing glue stick.	1	0112	2	Deleted
70	Sticking string on spider.	1	0112	2	Deleted

Redundant items 28, 34, 41, 50, 51 and 59 were deleted to improve item fit. Individual item-fit analysis showed redundant items for items 28, 34, 41, 50, 51, and 59 resulted in the deletion of items 6, 8, 28, 33 to 41, 50 to 51, 55, 59, and 70. ***Item-person fit*** investigated the responses of individuals to each of the items. An extreme person was found for child number 70, but after removal, the fit of items improved. The final analysis for praxis showed overall summary fit statistics as a mean item-fit residual score of 0.64 (SD=1.67). The person-item map, Figure 6.16 illustrated the person ability distribution compared to the item difficulty distribution for the praxis domain. The findings showed a mean person location of 0.93 (SD = 0.49), compared to an item location of 0.0 (SD = 0.41), indicating a poor match between item difficulty and the person ability for praxis, even though both scores fell within the ± 2.5 range.

Figure 6.16 shows that categories for several items were not endorsed and the categories were not able to discriminate between the item difficulty and the sample's ability.

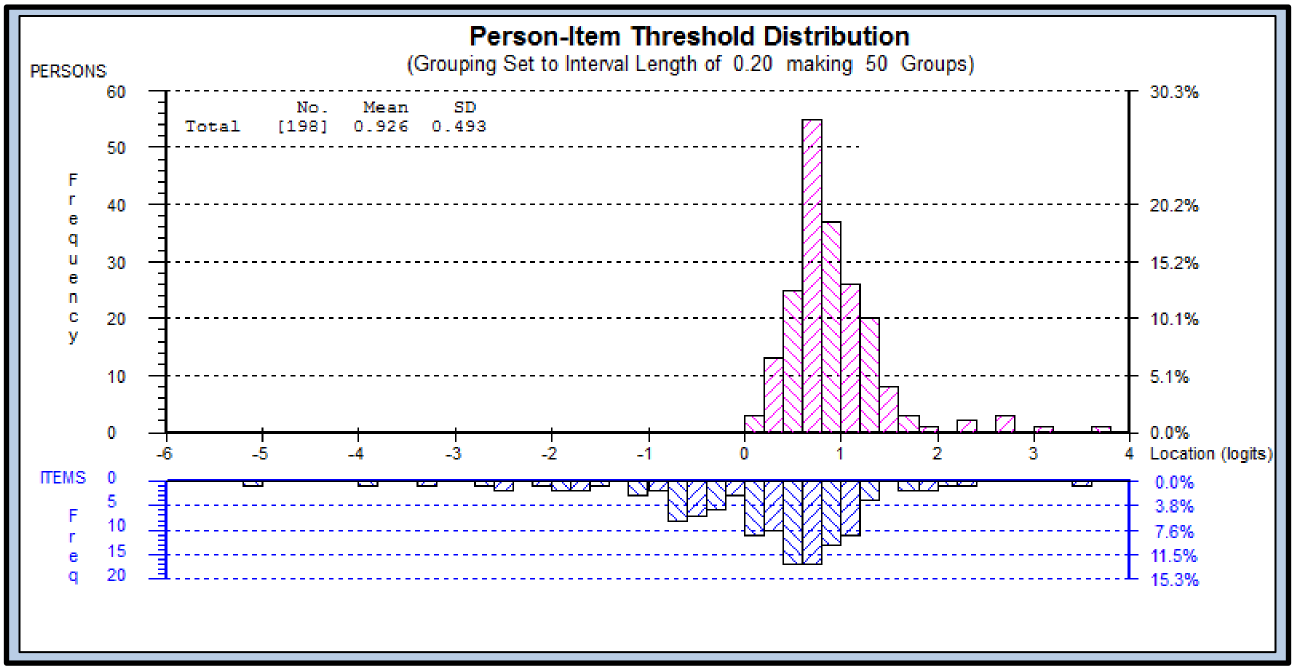


Figure 6.16: Praxis: Person-item threshold distribution map with persons (red) and items (blue) locations

Chi-square statistics provided further information on the item-trait (Hagquist et. al., 2009). Final analysis indicated a Chi-square value of p = 0.00, showing a significant difference between the data and the requirements of the Rasch model. Analysis of residual correlations generated ten subgroups for the praxis domain.

Two subtests were however found to fall outside the acceptable range of ± 2.5, as subtest 1 (3.37) and subtest 4 (2.78) scored above the ±2.5 level of acceptance and were therefore deleted. Final analysis indicated no ***local dependency,*** as presented in Table 6.32.

Table 6.32: Praxis: Local dependency (>0.3) - residual correlations

Item	ST01	ST02	ST03	ST04	ST05	ST06	ST07	ST08	ST09
ST01	1								
ST02	-0.054	1							
ST03	-0.093	0.049	1						
ST04	-0.220	-0.151	-0.114	1					
ST05	-0.108	-0.045	0.003	-0.117	1				
ST06	-0.100	-0.021	0.041	-0.227	0.187	1			
ST07	-0.115	0.000	-0.197	-0.333	-0.138	-0.009	1		
ST08	-0.085	0.183	-0.064	-0.474	0.017	0.150	0.041	1	
ST09	-0.082	-0.123	-0.095	-0.520	-0.058	0.071	-0.062	0.052	1

Differential item functioning determines whether subgroups within the sample respond differently to an item and may have advantages or disadvantages in comparison to other subgroups, e.g. bias in terms of gender. Table 6.33 shows that no significant bias was found between male and female children for the subtests. Some differences were found in subtest three between languages, and it was found that instructions needed to be more detailed.

Table 6.33 Praxis: differential item functioning for gender (p > 0.05)

Item	Male	Female	DF	Probability P > 0.05
ST01	10.79	5.62	1	0.02
ST02	0.01	0.01	1	0.92
ST03	0.39	0.38	1	0.54
ST04	1.98	1.70	1	0.19
ST05	0.77	0.89	1	0.35
ST06	1.40	2.13	1	0.15
ST07	0.20	0.20	1	0.65
ST08	0.26	0.35	1	0.55
ST09	2.39	2.51	1	0.11

A ***person separation index*** of 0 >.85 is an acceptable score to establish internal consistency. The internal consistency reliability of the praxis domain for the screening instrument was α = 0.84. An equating t-test was done, and ***uni-dimensionality*** was found to be > 11% which fell outside the recommended criteria of 5.

Binomial testing, however, showed a 0.08 lower confidence interval, and as this still fell within the range of ± 2.5 means it was legitimate to sum the subtests to obtain a total score.

In summary, the Rasch analysis of the data for the praxis domain did not fit the Rasch model as the domain failed to adhere to the criteria. The final analysis indicated that all thresholds were ordered and that the mean item-fit residual score did not fit the model as the mean of 0.64 (SD=1.67) needs to be 0.0 (SD = 1) or closer. A significant Chi-square of p = 0.00 indicated poor fit to the model as it was less than p > 0.05. No local dependency or differential item functioning for gender were found, however uni-dimensionality of 11% was much higher than the expected 5%.

6.3.2.2.5 Object handling

The object handling domain was subjected to three rounds of analysis to determine fit to the Rasch model. Firstly, the **threshold ordering** of the response categories for the subtests were investigated. In the first round of analysis one, it was determined that items 1, 3, 5, 6, 11, 18, 21, and 30 had disordered thresholds, meaning the response categories were not working as expected. These thresholds were ordered through the collapsing of scores. The second analysis showed that all the threshold categories were ordered. Table 6.34 shows the threshold ordering per analysis.

Table 6.34: Object handling: Threshold ordering per analysis

Item no	Item name	Number of analysis	Threshold ordering	Number of analysis	Ultimate action
1	GARMENT OFF Reaching for T-shirt/sleeves.	1	0012	1	Threshold ordered
3	GARMENT ON Grip of T-shirt/garment with hands.	1	0012	1	Threshold ordered
5	SAND Hand dominance/consistent hand use.	1	0012	1	Threshold ordered
6	SAND Three-point pincer grip when picking up the block.	1	0012	1	Threshold ordered
11	PATTERN Control of arm movements when reaching for the blocks.	1	0012	1	Threshold ordered
18	Copying of circle on back of hand.	1	0012	1	Deleted
21	Forming a cross with the clay worms.	1	0012	1	Threshold ordered
30	FOLDING Coordinated movements of hand and fingers.	1	0012	1	Threshold ordered

Item-person fit investigated the responses of individuals to each of the items and by the final analysis; eighteen items were deleted, as they did not fit the model. Analysis two showed ordered thresholds, but four items, item 10, 18, 19, and 20, did not fit and were deleted to improve the Chi-square value. Overall summary fit statistics resulted in a mean item-fit residual score of - 0.54 (SD= 0.76). Sixty-nine extreme persons were found, and 10 people did not fit the model, so their data were deleted to improve the fit to the model. The person-item map, Figure 6.15 shows the person ability distribution compared to the item difficulty distribution for the object handling domain. The findings illustrated a mean person location of 1.64 (SD = 0.51), compared to an item location of 0.0 (SD = 1.65), indicating a poor match between item difficulty and the person ability for handling of objects. Figure 6.17 shows that categories for several items were not endorsed and the categories were not able to discriminate between the item difficulty and the sample's ability.

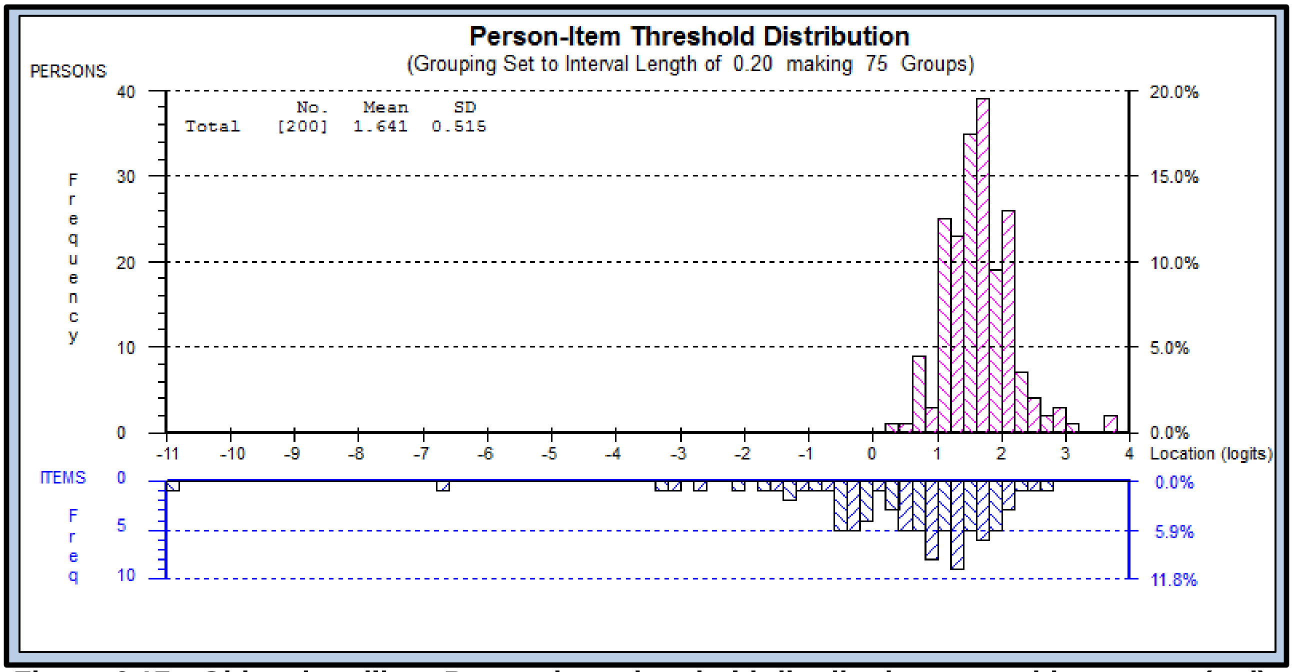


Figure 6.17: Object handling: Person-item threshold distribution map with persons (red) and items (blue) locations

Final analysis indicated a Chi-square value of p = 0.49, showing that a fit with the Rasch model as required. Analysis of residual correlations generated five subtests. Table 6.35 shows no ***local dependency*** was found in the final analyses, as all subtests obtained a residual correlation score of less than 0.30.

Table 6.35: Object handling: Local dependency (>0.3) - residual correlations

Item	ST01	ST02	ST03	ST04	ST05
ST01	1				
ST02	-0.035	1			
ST03	0.065	-0.152	1		
ST04	-0.094	-0.318	-0.224	1	
ST05	-0.213	-0.317	-0.360	-0.463	1

Differential item functioning showed that no significant bias was found between male and female children for the subtests, as can be seen in Table 6.36.

Table 6.36: Object handling: differential item functioning for gender

Item	Male	Female	DF	Probability P > 0.05
ST01	0.01	0.01	1	0.92
ST02	2.09	2.44	1	0.12
ST03	0.02	0.02	1	0.88
ST04	0.18	0.21	1	0.65
ST05	2.10	3.20	1	0.08

The ***person separation index*** (PSI) and was reported as a PSI > 0.76. This is an acceptable score to establish internal consistency.

An equating t-test was done, and ***uni-dimensionality*** was found to be 2.5%, which is less than the recommended criteria of 5%. This indicated the handling of object domain was uni-dimensional. Binomial testing, however, showed a -0.005 lower confidence interval.

In summary, the Rasch analysis of the data for the handling of objects domain did not fit all criteria of the Rasch model. The mean item-fit residual score of - 0.05 (SD = 0.76) needed to be 0.0 (SD = 1) to fit the model. Chi-square of p > 0.05 was obtained with a score of p = 0.49. No local dependency or differential item functioning for gender were found. Uni-dimensionality was reached as a score of 2.5%, which is lower than the required 5%, was obtained.

6.3.2.2.6 Visual form and space

Three rounds of analysis were used to determine the visual form and space domain's fit to the Rasch model. The initial **threshold ordering** map indicated that items 2, 3, 4, 5 and 23 did not fit and these item scores were collapsed, as seen in Table 6.37. Follow up analysis reported a good threshold map fit.

Table 6.37: Visual form and space: Threshold ordering per analysis

Item no	Item name	Number of analysis	Threshold ordering	Number of analysis	Ultimate action
2	Orientating T-shirt so that it faces the correct way to put it on again.	1	0122	2	Threshold ordered
3	Spatial perception of front and back of T-shirt.	1	0122	2	Threshold ordered
4	Put T-shirt on with label at the back	1	0122	2	Threshold ordered
5	GARMENT ON Knowledge of where body/body parts are in space.	1	0012	2	Deleted
23	Complete pattern 1 correctly within time	1	0122	2	Threshold ordered

Item-person fit investigated the responses of individuals to each of the items. During the second analysis, residual correlation was determined and items 6, 16, 19, 32 were deleted to improve item fit. Analysis three identified 35 redundant items, yet only 13 items, namely 1, 5, 6, 11, 12, 13, 14, 15, 16, 18, 19, 32 and 41 were deleted. The remaining 21 items were however kept as clinical assessment indicated that these items were relevant. The final analysis for the visual form and space domain showed overall summary fit statistics as a mean item-fit residual score of p = 0.31 (SD= 1.63). Although the mean item-fit residual score was not 0.00 (SD =1), as expected to fit the Rasch model, the scores still fell within the range of ± 2.5.

Initial residual correlations resulted in nine sub tests, but on further analysis, thirteen subtests were identified. Subtests 6 and 7 were combined into one subtest, and subtest 3 was redundant and therefore deleted, which resulted in 11 subtests. Further analysis indicated that subtest 1 (3.370) and subtest 7 (3.047) did not fit, as they fell outside the 2.5 range, and were therefore deleted. The person-item map, Figure 6.16, shows the person ability distribution compared to the item difficulty distribution for the visual form and space domain.

The findings show a mean person location of 0.62 (SD = 0.46), compared to an item location of 0.0 (SD = 0.43), indicating a poor match between item difficulty and the person ability for sensory perception. Figure 6.18 shows that categories for several items were not endorsed and the categories were not able to discriminate between the item difficulty and the sample's ability.

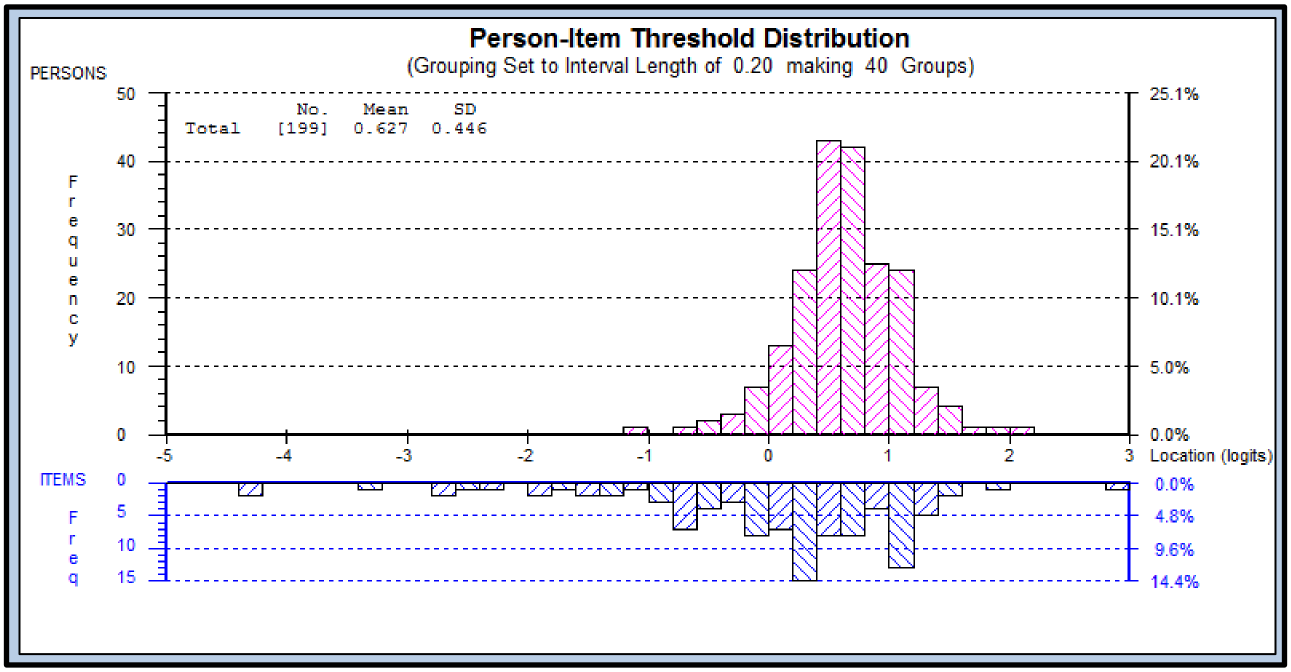


Figure 6.18: Visual form and space: Person-item threshold distribution map with persons (red) and items (blue) locations

Final analysis indicated a ***Chi-square value*** of p = 0.00, showing a significant difference between the data and the required Rasch model. This is an indication that the data did not fit the Rasch model as required. Residual correlations showed 12 subtests and no local dependency was reported. Table 6.38 shows that no local dependency was found as all residual correlations were less than 0.3.

Table 6.38: Visual form and space: Local dependency (>0.3) - residual correlations

Item	ST01	ST02	ST03	ST04	ST05	ST06	ST07	ST08	ST09	ST10	ST11	ST12
ST01	1											
ST02	0.059	1										
ST03	-0.103	0.248	1									
ST04	-0.126	-0.291	-0.259	1								
ST05	0.011	-0.034	-0.138	0.120	1							
ST06	-0.233	-0.388	-0.357	0.209	0.064	1						
ST07	0.016	-0.124	-0.029	-0.249	-0.280	-0.253	1					
ST08	-0.100	-0.121	-0.071	-0.030	-0.198	-0.183	0.125	1				
ST09	-0.084	-0.076	-0.082	-0.065	-0.136	-0.188	-0.084	0.019	1			
ST10	-0.027	-0.062	-0.045	0.030	-0.048	-0.216	-0.246	0.015	0.139	1		
ST11	-0.103	-0.087	-0.205	-0.093	-0.028	-0.046	-0.146	0.024	0.119	0.290	1	
ST12	-0.005	-0.129	-0.129	-0.056	-0.137	-0.108	-0.225	-0.125	-0.030	0.145	0.093	1

Differential item functioning determines whether subgroups within the sample respond differently to an item and may have advantages or disadvantages in comparison to other subgroups, e.g. bias in terms of gender. Table 6.39 shows significant bias between male and female children for subtests 2, 6 and 10.

Table 6.39: Visual form and space: differential item functioning for gender (p > 0.05)

Item	Male	Female	DF	Probability P > 0.05
ST01	1.63	0.89	1	0.346
ST02	3.27	3.34	1	0.069
ST03	13.21	11.37	1	0.001
ST04	3.37	4.84	1	0.029
ST05	1.36	1.93	1	0.167
ST06	15.98	21.43	1	0.000
ST07	1.05	0.85	1	0.358
ST08	1.15	1.28	1	0.260
ST09	1.18	1.36	1	0.244
ST10	7.75	9.46	1	0.002
ST11	0.07	0.08	1	0.776
ST12	0.01	0.01	1	0.930

Differential item functioning for subtest three showed a significant difference, p = 0.00, between male and female participants. The item characteristics curve for subtest 3, see Figure 6.19, showed that girls scored significantly higher on the visual form and space aspect of the positioning of the blocks in the poor and middle groups compared to the boys.

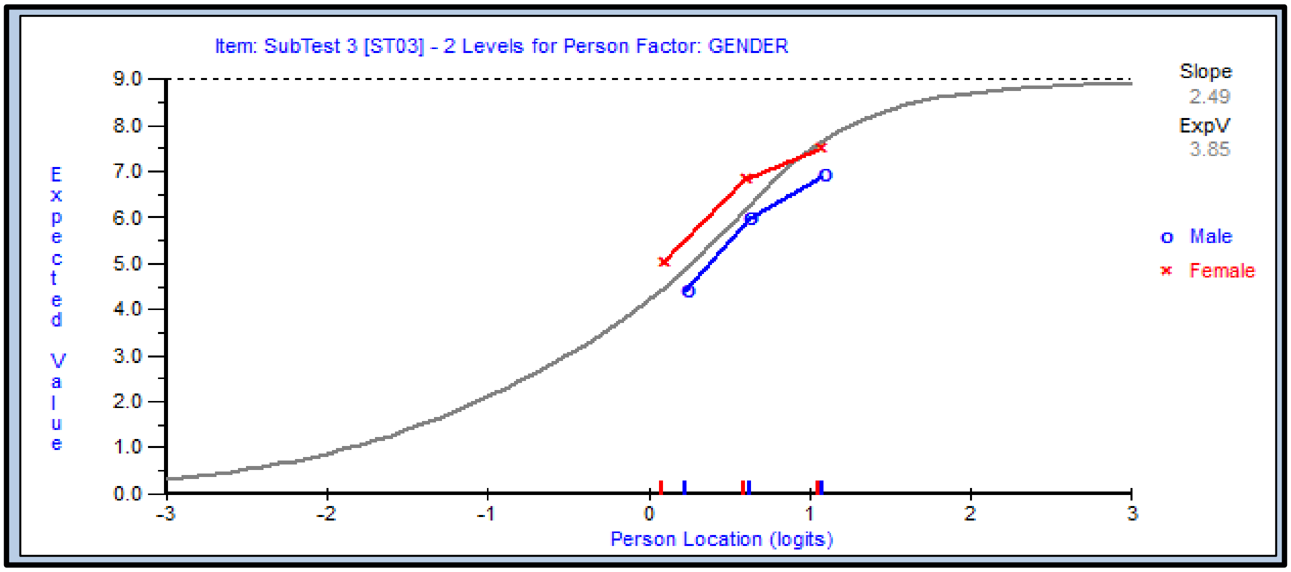


Figure 6.19: Visual form and space: Item characteristics curve for differential item functioning for sub tests 3

Differential item functioning for subtest six showed a significant difference, p = 0.00, between male and female participants. The item characteristics curve, seen in Figure 6.20, shows that males scored significantly higher on the copying of shapes on the back of the hand than the girls.

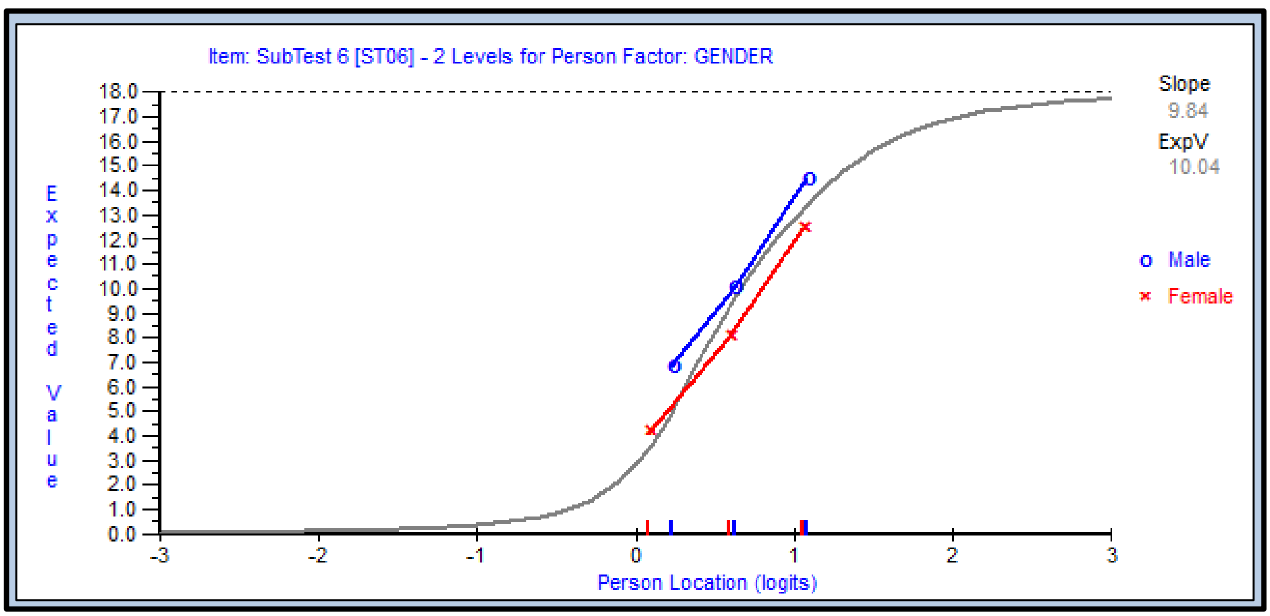


Figure 6.20: Visual form and space: Item characteristics curve for differential item functioning for sub tests 6

The item characteristics curve in figure 6.21, shows that subtest 10 girls scored significantly higher on the visual form and space domain of folding the spider's leg exactly on the line than the boys.

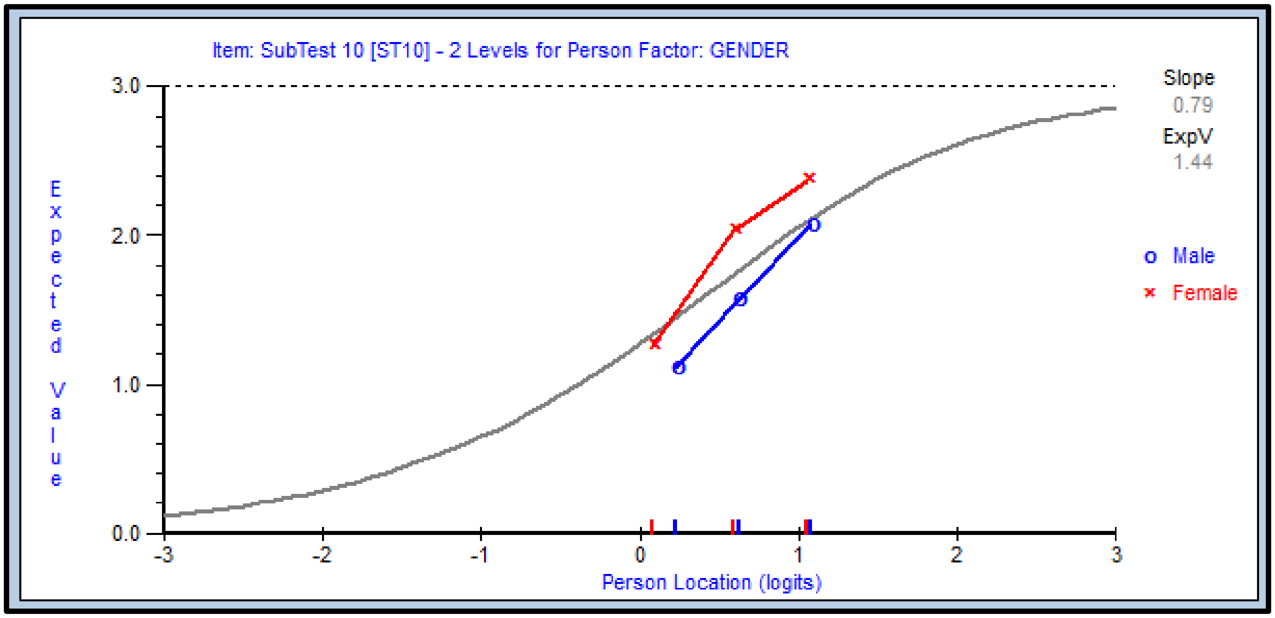


Figure 6.21: Visual form and space: Item characteristics curve for differential item functioning for sub tests 10

Reliability, as measured by the ***person-separated index,*** indicated a score of 0.83. This is close to the required PSI score of > 0.85 to establish internal consistency.

Uni-dimensionality was not achieved as the visual form and space domain obtained a score of 10%, which is higher than the required 5% for uni-dimensionality. Binomial testing, however, showed a 0.28 lower confidence interval, which means it was legitimate to sum the subtests to obtain a total score as it fell within the expected ± 2.5 range.

In summary, the Rasch analysis of the data for the visual form and space domain did not fit the Rasch model as the domain failed to adhere to all the criteria for uni-dimensionality. The mean item-fit residual score of 0.31 (SD = 1.63) needed to be 0.0 (SD = 1) to fit the model with a significant Chi-square of p = 0.0 instead of >0.05. No local dependency was reported but differential item functioning for gender was found for subtests 3, 6 and 10. Uni-dimensionality of 10% was higher than the expected < 5%.

6.3.2.2.7 Sensory reactivity

The sensory reactivity domain was subjected to two rounds of analysis to determine fit to the Rasch model. The sensory reactivity domain only had eight items and all ***thresholds*** were ordered.

Item-person fit investigated the responses of individuals to each of the items. The final analysis for sensory reactivity showed overall summary fit statistics, as a mean item-fit residual score of -0.13 (SD= 1.38) with items falling within the ±. 2.5 range for items to fit. The person-item map, Figure 6.21, shows the person ability distribution compared to the item difficulty distribution for the sensory reactivity domain. No abnormal person fit was identified and a mean person location score of p = 1.93 (SD = 1.30) indicated the person-item location fell within the ± 2.5 range. The person-item threshold map, seen in Figure 6.22, showed the ability of some persons was much higher than difficulty of the items, and that some items did not discriminate the ability of the persons.

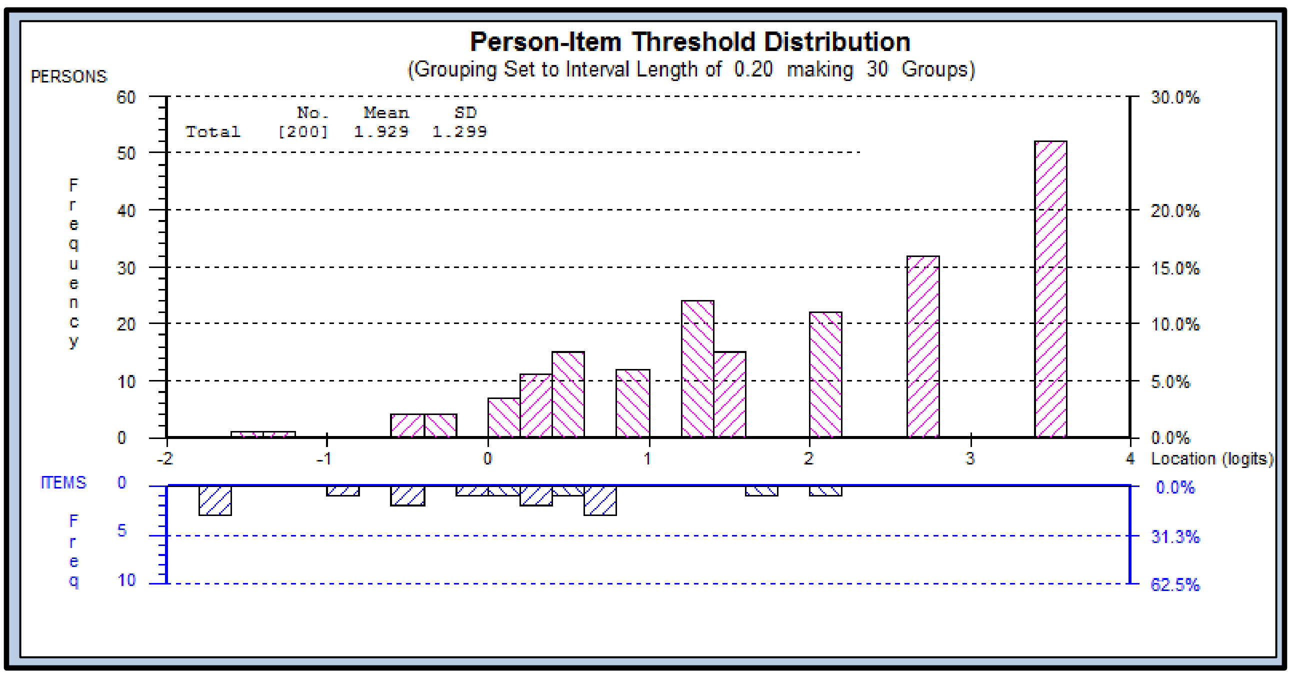


Figure 6.22: Sensory reactivity: Person-item threshold distribution map with persons (red) and items (blue) locations

Analysis indicated the sensory reactivity domain had a Chi-square of p = 0.000. This is an indication that the data did not fit the Rasch model as required. Residual correlation analysis showed no local dependence, as can be seen in Table 6.40.

Table 6.40: Sensory reactivity: Local dependency (>0.3) - residual correlations

Item	I0001	I0002	I0003	I0004	I0005	I0006	I0007	I0008
I0001	1							
I0002	-0.074	1						
I0003	-0.191	-0.043	1					
I0004	-0.276	-0.136	-0.138	1				
I0005	-0.044	-0.160	-0.221	-0.301	1			
I0006	-0.205	-0.193	0.194	-0.232	-0.064	1		
I0007	-0.218	-0.219	-0.198	-0.04	-0.038	-0.143	1	
I0008	-0.160	-0.154	-0.175	-0.228	-0.001	-0.090	-0.018	1

Differential item functioning, seen in Table 6.41, showed no bias for gender on any of the eight subtests.

Table 6.41 Sensory reactivity: differential item functioning for gender

Item	Male	Female	DF	Probability P > 0.05
I0001	1.95	2.24	1	0.14
I0002	0.21	0.22	1	0.64
I0003	2.83	3.09	1	0.08
I0004	4.38	3.69	1	0.06
I0005	0.43	0.73	1	0.40
I0006	0.01	0.01	1	0.93
I0007	0.00	0.00	1	0.99
I0008	2.44	3.25	1	0.07

The **PSI** for sensory reactivity was 0.53 indicating a low internal consistency.

An equating t-test was done, and **uni-dimensionality** was found to be 1.5% that indicates fit to the Rasch model. Binomial testing showed a - 0.02 lower confidence interval and fell within the expected ± 2.5 range. This means that it will be legitimate to sum the subtests to obtain a total score.

In summary, the Rasch analysis showed an acceptable person separation index of p > 0.85 and a uni-dimensionality score of 1.5% that shows that this domain fit some of the requirements of the Rasch model.

6.3.2.2.8 Organisation of space and environment

The organisation of space and environment domain was subjected to one round of analysis to determine fit to the Rasch model. The organisation of space and environment domain only had five items and all **t*hresholds*** were ordered. The analysis generated a mean item fit residual score of - 0.14 (SD = 1.11), which was within the range of ± 2.5. No abnormal person fit was identified and a mean person location score of p = 4.35 indicated that the person-item location fell out of the ± 2.5 range. Individual item fit analysis revealed that item 1 (3.84) and item 4 (-2.69) did not fit and fell outside the ± 2.5 range.

No sub-testing was done, and no **local dependency** was found. The person-item map, Figure 6.23, shows the person ability distribution compared to the item difficulty distribution for the organisation of space and environment domain. This map showed that some items, indicated in blue, did not measure the person's ability and some persons, indicated in red, showed that some person's ability were not measured by the items. Analysis indicated that this domain had a Chi-square of p = 0.00, an indication that the data did not fit the Rasch model as required.

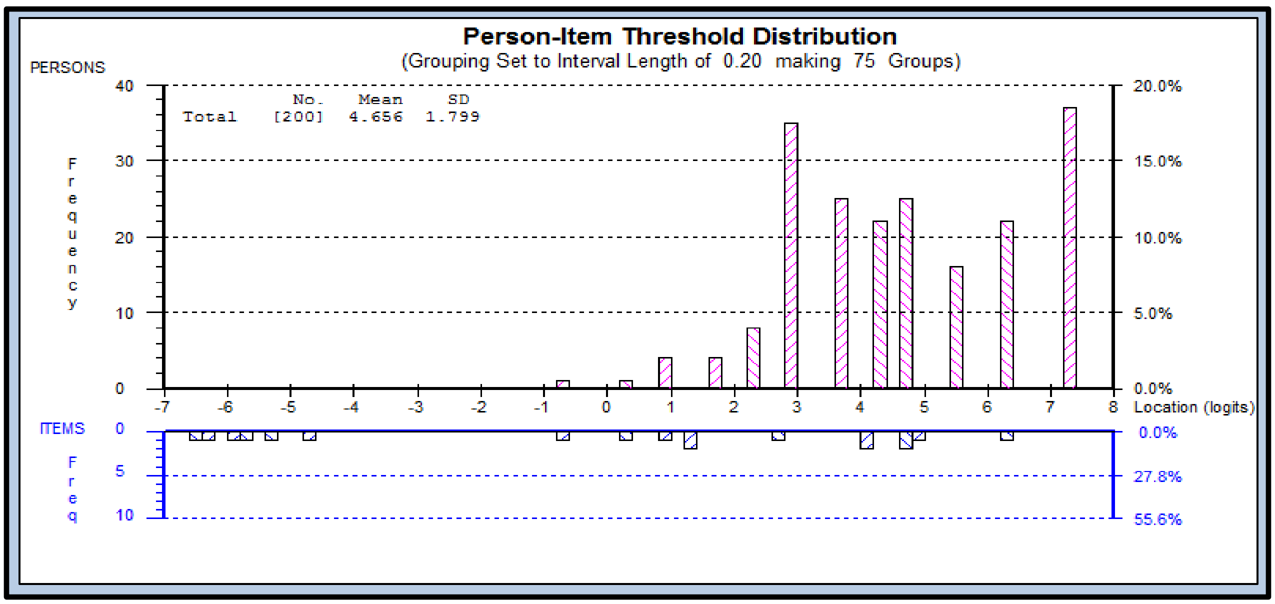


Figure 6.23: Organisation of space and environment: Person-item threshold distribution map with persons (red) and items (blue) locations

No residual correlations were found with no **local dependency**. Table 6.42 provides more information on the residual correlations.

Differential item functioning for gender showed no significant difference between male or female participants.

Table 6.42: Organisation of space and environment: Local dependency (>0.3) - residual correlations

Item	I0001	I0002	I0003	I0004	I0005	I0006
I0001	1					
I0002	-0.339	1				
I0003	-0.255	-0.196	1			
I0004	-0.147	-0.274	-0.089	1		
I0005	-0.458	-0.098	0.125	-0.092	1	
I0006	-0.210	-0.088	-0.190	-0.298	-0.156	1

A **person separation index** of 0.69 was found, which is less than the required >0.85 for fit to the Rasch model.

An equating t-test was done, and **uni-dimensionality** was found to be 0.53%, indicating marginal fit to the Rasch model. Binomial testing showed a - 0.03 lower confidence interval, which means it was legitimate to sum the subtests to obtain a total score.

6.3.2.2.9 Organisation of self and behaviour

The organisation of self and behaviour domain was subjected to three rounds of analysis to determine fit to the Rasch model. The organisation of self and behaviour domain had 11 items. The initial ***threshold ordering*** map indicated that item 9 did not fit well and as the domain had a skewed mean score, and it was therefore deleted. The second analysis showed a disordered threshold and all items were changed to a dichotomous scale of yes/no. See Table 6.43.

Item-person fit investigated the responses of individuals to each of the items, and the final analysis for organisation of self and behaviour showed overall summary fit statistics as a mean item-fit residual score of - 0.22 (SD= 1.23), which was within the range of ± 2.5. Twenty-eight extreme persons were identified, and person fit was identified with a mean person location score of 4.35 indicating the person-item fell outside the ± 2.5 range. The 28 extreme persons for this domain all obtained a score of 4 (highest score) for all the times.

Table 6.43: Organisation of self and behaviour: Threshold ordering per analysis

Item no	Item name	Number of analysis	Threshold ordering	Number of analysis	Ultimate action
1	Attention during the execution of the tasks.	2	0022 Yes/no	2	Threshold ordered
2	Ability to initiate activity.	2	0022 Yes/no	2	Threshold ordered
3	Ability to complete the activity.	2	0022 Yes/no	2	Threshold ordered
4	Ability to organise environment and body to the tasks.	2	0022 Yes/no	2	Threshold ordered
5	Ability to organise environment and body to the tasks.	2	0022 Yes/no	2	Threshold ordered
6	Organisation of self and behaviour.	2	0022 Yes/no	2	Threshold ordered
7	Ability to follow verbal instructions.	2	0022 Yes/no	2	Threshold ordered
8	Ability to follow non-verbal instructions/demonstrations.	2	0022 Yes/no	2	Threshold ordered
9	Participation in activities/Motivation.	1	Misfit	1	Deleted
10	Facial expressions.	2	0022 Yes/no	2	Threshold ordered
11	Interaction with examiner.	2	0022 Yes/no	2	Threshold ordered

All items were rescored to yes/no, which improved the Chi-square score, but the reliability declined and showed it did not discriminate well. The person-item map, Figure 6.24, shows the person ability distribution compared to the item difficulty distribution for the sensory perception domain.

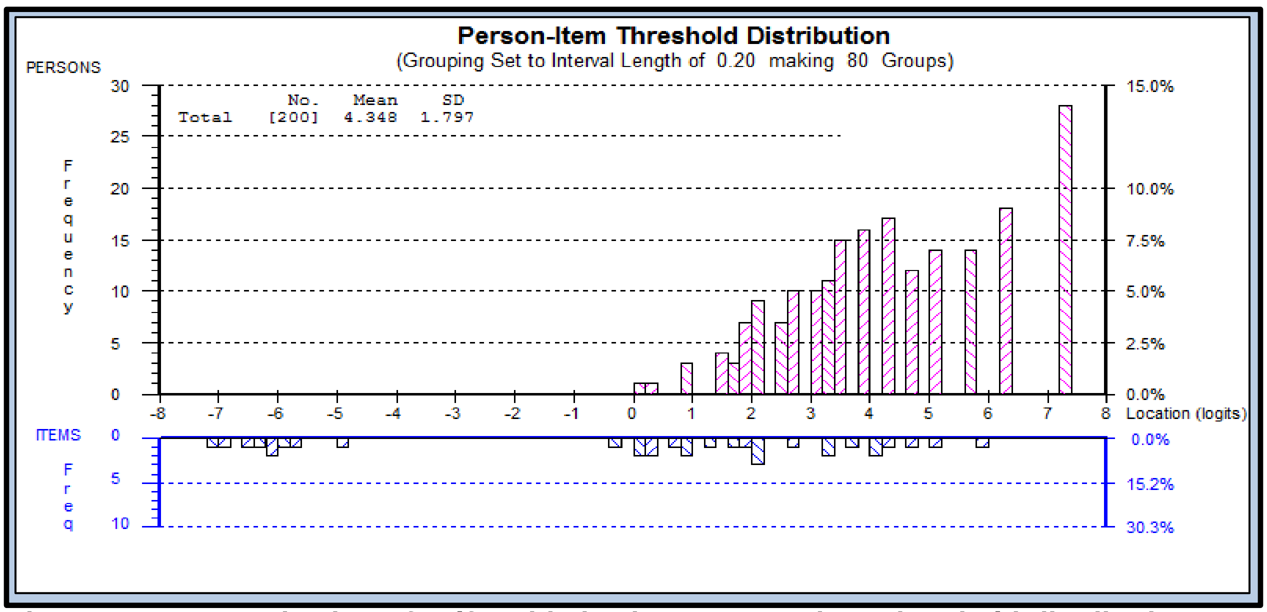


Figure 6.24: Organisation of self and behaviour: Person-item threshold distribution map with persons (red) and items (blue) locations

Figure 6.24 shows that categories for several items were not endorsed and the categories were not able to discriminate between the item difficulty and the sample's ability.

Final analysis indicated the organisation of self and behaviour had a ***Chi-square*** of p = 0.00, an indication the data did not fit the Rasch model as required. Analysis of ***residual correlations*** did not generate any subtests. Eleven residual correlations were found, as can be seen in Table 6.44. Residual correlations were seen between Items 6 and 4 (0.352), Items 12 and 8 (0.312), Items 10 and 9 (0.379), Items 11 and 9 (0.521), Items 12 and 11 (0.422), Items 15 and 11 (0.337), Items 17 and 11 (0.384), Items 14 and 13 (0.606).

A **PSI** of >0.85 is an acceptable score to establish internal consistency. The internal consistency of the instrument was 0.81.

Uni-dimensionality was found to be 4%, indicating fit to the Rasch model and that it would be legitimate to sum the subtests to obtain a total score. Too few items correlated positively, and it was therefore not possible to do a t-test to determine the confidence intervals.

Table 6.44: Organisation of self and behaviour: Local dependency (>0.3) - residual correlations

Item	I0001	I0002	I0003	I0004	I0005	I0006	I0007	I0008	I0009	I0010	I0011	I0012	I0013	I0014	I0015	I0016	I0017
I0001	1																
I0002	-0.005	1															
I0003	0.013	0.209	1														
I0004	-0.026	0.195	0.269	1													
I0005	0.015	0.190	0.044	0.158	1												
I0006	0.074	0.275	0.165	0.352	0.260	1											
I0007	-0.080	-0.153	-0.101	-0.349	-0.216	-0.156	1										
I0008	-0.102	-0.209	-0.244	-0.285	-0.381	-0.330	-0.029	1									
I0009	-0.136	-0.357	-0.253	-0.284	-0.338	-0.465	0.162	0.278	1								
I0010	-0.109	-0.232	-0.161	-0.236	-0.250	-0.266	0.048	0.202	0.379	1							
I0011	0.052	-0.372	-0.269	-0.243	-0.310	-0.529	-0.108	0.274	0.521	0.238	1						
I0012	-0.015	-0.336	-0.175	-0.407	-0.392	-0.412	0.199	0.312	0.295	0.242	0.422	1					
I0013	-0.206	-0.316	-0.243	-0.340	-0.295	-0.293	0.210	0.207	0.048	0.023	-0.045	0.144	1				
I0014	-0.170	-0.299	-0.144	-0.344	-0.276	-0.311	0.124	0.227	0.055	-0.022	0.113	0.138	0.606	1			
I0015	-0.153	-0.347	-0.185	-0.268	-0.373	-0.546	0.071	0.237	0.239	0.147	0.337	0.173	0.282	0.309	1		
I0016	-0.128	-0.121	-0.163	-0.148	-0.108	-0.182	0.055	0.070	0.130	0.040	0.017	-0.048	0.057	-0.122	0.141	1	
I0017	-0.169	-0.284	-0.172	-0.198	-0.325	-0.440	-0.129	0.092	0.282	0.164	0.384	0.239	0.095	0.015	0.418	0.392	1

In conclusion, the Rasch analysis found that only the bilateral integration and sequencing and the object handling domains fit the Rasch model criteria for Chi-square scores of >0.05. None of the domains fitted the mean item fit residual of 0.00 and a mean item fit residual SD of 1, but individual item fit analysis did show that all scores for items fell within the range of ± 2.5, except for the praxis, visual form and space and organisation of space and environment domains. Local independence was only identified in the organisation of self and behaviour domain with 11 residual correlations. Differential item functioning was only found in the visual form and space domain between the female and male scores for three subtests. The person separation index provided information on the reliability of the domains. A PSI of >0.85 was required for fit to the Rasch model. No domain reached this criterion, although the praxis (0.84), visual form and space (0.83) and the organisation of self and behaviour (0.81) domains came close to this goal. The PSI for the sensory reactivity (0.53) and organisation of space and environment domains (0.69) were well below the criteria. Only four domains, namely object handing (2.5%), sensory reactivity (1.5%), organisation of space and environment (0.53%) and organisation of self and behaviour (4%), were uni-dimensional as they reached the recommended criteria of 5% for fit to the Rasch model. Binomial testing, however, showed the confidence intervals for scores within a range of ± 2.5 for domains, which meant that total scores for the domains, could be summed. No one domain met all the criteria for the Rasch model, but the analysis provided valuable information on the psychometric properties of the SASISI.

6.3.3 Objective 3: To establish the clinical utility of the newly developed sensory integration screening instrument, e.g. appropriateness for use and difficulties with administration and scoring.

In Objective 3, the researcher wanted to determine the appropriateness and usefulness of the SASISI to establish clinical utility of the instrument. The results for this qualitative investigation are discussed in 6.3.3

6.3.3.1 Research assistant sample for clinical utility

Four occupational therapists assisted the researcher in the field-testing of the screening instrument. Table 6.45 describes the research assistant demographics.

Table 6.45: Sample demographics for establishing clinical utility of the SASISI

	Researcher	Assistant 1	Assistant 2	Assistant 3	Assistant 4
Culture	White	Black	Black	White	White
Home language	Afrikaans/ English	Shona/English	Setswana/ Venda/English	English/Afrikaans	Afrikaans/English
Highest qualification	MSc OT.	B.Sc. OT	B. Occ. Therapy.	B. OT	B. OT
University qualification obtained	University of the Witwatersrand	Zimbabwe	University of Limpopo	University of Pretoria	University of Pretoria
Years' OT experience	16 years	5 Years	5 Years	4 Years	2 years
Years paediatric experience	16 years	4 Years	5 Years	2 Years	1 Year
Highest level of SI training	SIPT qualified Completed SI C1-C4 training Lecturer SAISI courses	Masters in Paediatric course completed	SI Theory	SI Theory	Basic undergraduate SI knowledge

All four therapists had less than five years of experience in occupational therapy, as well as in the field of paediatrics. This is similar to the target group of occupational therapists who will be using the screening instrument. One research assistant completed a Master's degree in paediatric occupational therapy, and two of the assistants had training in the theoretical course for sensory integration. All research assistants spoke English but were also bilingual and able to speak either Afrikaans, Shona, Setswana or Venda. They trained at different training institutions with two graduating from the University of Pretoria, one from the University of Limpopo and one from Zimbabwe. This analysis showed that the research assistants were from a variety of diverse backgrounds and training institutes and had various levels of experience and knowledge.

6.3.3.2 Thematic analysis of interviews with research assistants

Individual interviews with the research assistants were transcribed and thematically analysed. Table 6.46 describes the findings of the thematic analysis

Table 6.46: Findings of the thematic analysis of interviews with research assistants on the clinical utility of the screening instrument

Theme: Instrument design		
Category	**Subcategory**	**Codes**
Purpose of design	Unique design	• First of its kind • Will have positive influence on education • Will inform teachers on SI difficulties • Covers basic SI skills
	Appropriateness of design	• Appropriate for age group • Appropriate for low socio-economic population
Equipment	Appropriateness of equipment	• Equipment appropriate for children's scholastic level • Equipment appropriate for use in low socio-economic environments • Equipment that is well known
	Ease of access to equipment	• Equipment easy to get • Equipment easy to assemble in a kit • Use of own clothes for dressing activity
Theme: Language and instructions		
Category	**Subcategory**	**Codes**
Instructions	Ease of instructions	• Instructions easy to understand • Instructions clear • Able to administer items using basic verbal instructions
	Demonstrations	• Demonstrations worked well • Demonstrations helped when understanding was poor
	Difficulties with instructions	• Instructions for spider cutting activity needs to be more detailed • Instructions for drawing on the back of the hand in the clay activity needs to be adapted • Children found the instructions for walking heel toe difficult
Language	Language barriers	• Different languages were problematic • Cheat sheet helped a lot • More Tswana instructions are needed
Theme: Use of activities for measurement		
Category	**Subcategory**	**Codes**
Characteristics of activities	Positivity in using activities	• Activities have a playful element • Activities are familiar and well known • Activities were well analysed • Activities were exciting for children • Take home activities are gratifying
	Additions needed to activities	• Add ball skills • Dressing activity to be a general observation

Table 6.46: Findings of the thematic analysis of interviews with research assistants on the clinical utility of the screening instrument - continue

Theme: Administration procedures and guidelines		
Category	**Subcategory**	**Codes**
Execution of administration guidelines	Ease of administration	• Easy to administer • GM items easy to administer • Increased practice made administration easier
	Administration manual	• Manual well organised • Manual lay out easy to follow • Manual comprehensive • Manual easy to understand and use
Training in use of screening instrument	Administration training	• Training was useful • Training helped with proper administration of activities • Online training was beneficial
	Scoring training	• Found observation of scoring helpful • Case studies were helpful for scoring • Practice of scoring is necessary
Theme: Scoring		
Category	**Subcategory**	**Codes**
Positive aspects of scoring	Ease of scoring	• Scoring easy • Scoring easy to execute while child continues with activity • Scoring easy to understand • Scoring easy to identify SI problem
	Scoring sheet	• Scoring sheet was easy to use • Calculating scores at end of sheet time consuming • Electronic/computerised scoring will work
Negative aspects of scoring	Difficulty in scoring	• Borderline scores challenging • Assigning different scores to the three scoring aspects difficulties • Scoring behavioural domains difficult • Scoring sensory reactivity was confusing
	Changes needed	• Change scoring behavioural aspects to yes/no • Provide more observations with scoring • Need more detail for scoring observations

The first theme that emerged focused on the purpose of and appropriateness of the instrument design, the equipment chosen for the instrument and the fit of the training to the purpose of the instrument. The research assistants indicated that the screening instrument was well designed, activities were well analysed for the age group and the equipment used was appropriate for children from low socio-economic environments.

Research assistant 2*: "***Most importantly I think it is the first of its kind and has the capability of influencing the whole education system of this age group in the low socio-economic environments and informing teachers about the potential causes of decreased function in schools and paving in the role of occupational therapists in these schools.***"*

Research assistant 3: ***"The screening instrument was very well analysed, and most children easily understood what they had to do and were familiar with the task or similar tasks."***

The second theme identified was for the use of instructions and the language of instructions in the screening instrument. The research assistants found the instructions used were clear and easy to understand and the use of demonstrations when a child did not understand the instructions worked well.

Research assistant 1: ***"Instructions are clear throughout the test."***

Research assistant 4: ***"Demonstration made it easier for children to understand."***

Research assistant 3***: "The cheat sheet with words for different languages worked well."***

The third theme that emerged focused on the use of activities as a measurement, and the individual activities that were used. Activities were found to have a playful element, were familiar and well analysed. The research assistants found that the dressing activity was too easy for the children and suggested that the use of zips, buttons and tying shoelaces be added.

Research assistant 2: ***"The use of concepts like, building a tower and making a spider are universal and easy to understand."***

Research assistant 4: ***"The cutting of the spider activity was nice as children liked having an end-product that they could take home."***

Research assistant 1***: "The order of the activities builds up in such a way that a lot of different information could be seen, e.g. the build up from finding the blocks in the sand, followed by the clay shapes activity provided information on tactile responses."***

Theme four focused on the ease of administration and the use of the administration manual. All four research assistants found the administration manual easy to understand and use. The research assistants also found the training on the administration of the screening instrument was useful and necessary before the use of the instrument. The online training was beneficial, but it was recommended that a face-to-face session was needed for the practice of the scoring.

Research assistant 2: ***"The manual is clear with comprehensive administration instructions for the activities. The diagrams included also helped a lot."***

Research assistant 3: ***"I had no difficulties with the administration and found that the more you did it, the easier it was."***

Research assistant 2: ***"Training was adequate as the manual is very comprehensive and just by reading it, one can easily administer the test; however it helped to observe the researcher as she did the first few assessments."***

The final theme focused on the scoring of the screening instrument, the ease or difficulty of scoring using the scoring sheet and proposed changes for the scoring system. The research assistants found the scoring system easy to use and to identify sensory integration difficulties. They commented that the scoring sheets were easy to use yet suggested an electronic scoring system to calculate total scores as this was quite time consuming. The biggest difficulties with the scoring system were for scoring the children on three aspects and deciding which aspect to use, when to give a borderline score and the scoring of the behavioural aspects. Suggested changes to the scoring system included the provision of more detailed observations to guide scoring and changing the behavioural scores to a yes/no answer rather than using a numeric score.

Research assistant 2: ***"The scoring took long at first but with time it got easier to do. The way the activities are scored according to SI items made it easy to identify sensory integration problems. The borderline scores were a bit challenging; also assigning a different score to each observation item was a bit difficult particularly with the borderline children."***

Research assistant 4***: "More detail on the scoring in terms of observations will help as sometimes I had to go back to check what the observations means."***

Research assistant 3***: "I had some difficulty scoring the behaviour part on the back page. It will be helpful if you give a score of yes/no for behaviour instead of a score."***

In conclusion, the thematic analysis provided valuable information on the clinical utility of the instrument and proposed changes to make it more user friendly. The positive feedback from the research assistants on the clinical utility of the instrument is encouraging and confirms the SASISI will be useful to occupational therapists with minimum sensory integration knowledge working within low socio-economic environments. The results of the Rasch analysis and the feedback on the clinical utility of the SASISI were used to change and refine the SASISI for future use.

6.3.3.3 Changes and refinement of the SASISI

Changes to observations and scoring were made to the SASISI to individual activities as proposed by the research assistants. These revisions are discussed in Table 6.47 in more detail. Changes to these individual activities were also made in the manual and the administration guidelines.

Table 6.47: Changes made to individual activities in the SASISI as proposed by the research assistants

Activity	Changes made to the instrument
Dressing activity	Added observation for: *Opening & closing buttons/zips/laces* as suggested.
Heel-toe walking	Changes made to the manual. Ensure the manual states that administrator provides appropriate demonstration for walking heel-toe.
Star jumps	Changes made to the manual. Ensure the manual emphasises to administrator that the appropriate demonstration is used for star jumps. Ensure the child understands that he/she must copy the administrator precisely.
Block activities	Changes made to equipment: To use the smaller blocks for tactile discrimination in sand.
Clay activities	Changes made to instructions: More detailed instructions for drawing on hand and the order that the activity needs to be administer in.
Cutting activity of spider.	Changes made to spider picture: Child is only to colour in the shapes on the spider's body rather than the whole body to limit time spent on colouring in. Changes to instructions: Administrator to emphasise to child that their picture needs to look the same as the example.
Sensory modulation observations	Changes made to scoring: Only yes/no scoring for behaviour observed. Administrator to tick the behaviour most observed.
Organisation of space and environment	Changes made to scoring: Only yes/no scoring for behaviour observed. Administrator to tick the behaviour most observed.
Organisation of self and behaviour	Changes made to scoring: Only yes/no scoring for behaviour observed. Administrator to tick the behaviour most observed.

Table 6.48 describes the overall changes that were made to the SASISI, such as defining of observations in more detail, the changes and refining of the item scoring and the updates to the manual and overall scoring sheet.

Table 6.48: Overall changes made to the SASISI

<table>
<tr><th></th><th>Changes made for the screening instrument</th></tr>
<tr><td>Define observations in more detail</td><td>
Refined and extended observations by:

Defining items in more detail in terms of what needs to be measured, e.g. “The child knows how to start and execute the task of taking of the garment. instead of “The child can start the activity.”
Added column to make clear what area of sensory integration is being measured. “Praxis: - Ideation, - Motor execution”

Example of first copy of item descriptors:
<table>
<tr><th>Activity</th><th>Item descriptor</th></tr>
<tr><td rowspan="2">Walking heel-toe</td><td>Initiation of task</td></tr>
<tr><td>Posture in standing</td></tr>
</table>
Example of updated version of item descriptors:
<table>
<tr><th>Item descriptor</th><th>Observations indicating difficulty</th></tr>
<tr><td>Initiating the walking on the line as demonstrated</td><td>* Does not know where to start on the line
* Does not know how to walk heel toe on the line even after demonstration
* Movements seem clumsy
* Poor flow of movements</td></tr>
<tr><td>Posture during walking on line</td><td>* Postural alignment while walking is poor
* Poor balance while walking - over use of arms to maintain balance & swaying a lot
* Fixates with shoulders and hips while walking</td></tr>
</table>
</td></tr>
<tr><td>Refine item scoring</td><td>
1. Refined scoring:

Defining scores in more detail of what needs to be measured, e.g. score of 1 = “Severe difficulties starting, executing or completing a task with accuracy, control and quality AND/OR needs more than 75% verbal/physical assistance.”

Example of first copy of scoring:
<table>
<tr><th>Score</th><th>Assistance needed</th><th>Quality & accuracy of task execution/ product</th><th>Movements</th></tr>
<tr><td>1</td><td>Unable to execute activity even with verbal/physical assistance</td><td>Poor quality and severe difficulties with accuracy of task/product execution.</td><td>Severe difficulties with coordination, speed and control of movements.</td></tr>
</table>
Example of updated version of scoring:
<table>
<tr><th>Score</th><th>Description</th><th>Comment</th></tr>
<tr><td>1</td><td>Severe difficulties starting, executing or completing a task with accuracy, control and quality, AND/OR
Needs more than 75% verbal/physical assistance.</td><td>Accuracy
Control
Quality
Assistance</td></tr>
</table>
Adding an additional mechanism to check correctness of scoring, e.g. therapist needs to tick what type of difficulty the child is experiencing, i.e. does the child have difficulty with accuracy, control, quality or needs high levels of assistance. In the comments area the administrator ticks:
“COMMENTS (indicate with √ which area difficulties were experienced in) Accuracy, Control, Quality, Assistance”

2. Introduced computerised scoring system using Excel to add scores for each domain. An excel spreadsheet was developed for scoring and totalling of scores.
</td></tr>
<tr><td>Updated manual & scoring sheet</td><td>Updated the manual and scoring sheet with changes.
Developed a scoring booklet for ease of instructions, scoring and providing instructions.</td></tr>
</table>

The original scoring system is illustrated in Table 4.48 and changes to the scoring system resulting in a more detailed scoring as seen in Table 4.49.

Table 6.49: First description of item descriptors and scoring of the screening instrument

WALKING HEEL TOE	OBSERVATIONS	Sensory Discrimination	Postural Ocular control	Skills: Bilateral integration & sequencing	Praxis	Handling of Objects: Hand function	Skills: Visual Form & Space
Walking forward with eyes open	Initiation of task						
	Posture in standing						
	Postural changes while moving						
	Knowledge of body parts where heel and toe of the foot is)						
	Balance during walking forward						
	Use of visual guidance during activity						
	Equilibrium reactions during walking on line.						
TOTAL SCORE							

The scoring sheet, as seen in Table 6.50, was refined to include the steps of the activity, the sensory integration domain that is being measured, the observations that can indicate difficulties in the specific domain and the scoring of the observation based on a score of 1 to 4. An addition to the scoring system is the inclusion of four indicators of performance, which include accuracy, control, quality and assistance. The administrator will observe the child during the execution of the step and if a score of three or less is marked, the administrator will tick the indicator/s that influenced the child's performance. These indicators will not generate a score but will provide valuable clinical information on the child's performance and aid in the interpretation of the child's performance.

Table 6.50: Refined version of item descriptors and scoring following revision of the SASISI

WALKING HEEL TOE							
STEPS OF ACTIVITY	**SI DOMAIN MEASURED**	**OBSERVATIONS THAT COULD BE AN INDICATION OF DIFFICULTIES** (indicate with √ which area difficulties were experienced in)	**Severe difficulties starting, executing or completing a task with accuracy, control and quality AND/OR Needs more than 75% verbal/physical assistance.**	**Able to start, execute or complete a task with some difficulties in at least 2 areas in terms of accuracy, control and quality AND/OR Needs more than 50% verbal/physical assistance.**	**Able to start, execute or complete a task with slight inconsistencies in at least 1 area in terms of accuracy, control and quality AND/OR Minimal verbal/physical assistance needed < than 2 times during activity.**	**Good accuracy, control and quality of movements/tasks during execution. No verbal/physical assistance needed.**	**COMMENTS** (indicate with √ which area difficulties were experienced in)
1. WALKING HEEL TOE - EYES OPEN							
Posture during walking on line	Postural - Postural tone - Balance - Postural adjustments	* *Low postural tone observed* * *Postural alignment while walking is poor* * *Poor balance while walking - over use of arms to maintain balance & swaying a lot* * *Fixates with shoulders and hips while walking*	**1**	**2**	**3**	**4**	Accuracy ☐ Control ☐ Quality ☐ Assistance ☐
Initiating the walking on the line as demonstrated	Praxis - Ideation - Motor planning - Motor execution	* *Does not know where to start on the line* * *Does not know how to walk heel toe on the line even after demonstration* * *Movements seem clumsy* * *Poor flow of movements*	**1**	**2**	**3**	**4**	Accuracy ☐ Control ☐ Quality ☐ Assistance ☐
Body scheme while moving	Discrimination - Proprioception - Vestibular	* *Poor knowledge of body e.g. where body and feet are & how it relate to each other in movement* * *Uses heavy movements to position feet* * *Hit one foot hard with other foot*	**1**	**2**	**3**	**4**	Accuracy ☐ Control ☐ Quality ☐ Assistance ☐
Postural changes while moving	Postural - Postural tone - Balance - Postural adjustments	* *Fixates body in order to maintain balance during task* * *Poor lateral flexion and trunk rotation when walking on line* * *Poor speed of movement to control movements*	**1**	**2**	**3**	**4**	Accuracy ☐ Control ☐ Quality ☐ Assistance ☐

6.3.4 Summary of the results of Phase Two

Phase two set out to field test the screening instrument, to establish the internal construct validity and the clinical utility of the screening instrument. The results of Objective 1, which included the pilot testing, showed some difficulties with the clarity of the instructions and language use for administration. Changes were made to the instructions and a sheet with key terms for the six languages were developed to aid in the verbal instructions for the activities. Changes were made to the clay and spider cutting activities for ease of administration. Scoring guidelines were described in more detail.

Objective 2 included the field-testing of 200 children from low-socio economic environments to determine the internal construct validity. Analysis of the background information confirmed that the children included in the sample had the same risk factors as those identified during the literature review, namely low income, poor living conditions, living mainly with the mother with below average schooling. The results of the Rasch analysis for the SASISI indicated that not all domains adhered to the Rasch model criteria, with only four subdomains reaching uni-dimensionality. Even though the domains did not fit the Rasch model it was found that most items fell within the item fit range of ± 2.5, and binomial testing indicated the total scores could be summed. The findings were however encouraging as they illustrated the SASISI shows promise in identifying sensory integration difficulties.

In Objective 3, five themes emerged in determining the clinical utility of the screening instrument. The themes included the design of the instrument, the use of language and instructions, use of activities as measurements, the administration format and the scoring format. Research assistants indicated it was a suitable instrument for use by community service occupational therapists working in low socio-economic environments to determine sensory integration difficulties. The SASISI was refined based on the results of the Rasch analysis and the feedback on the clinical utility of the instrument.

6.4 RESULTS FOR PHASE THREE

6.4.1 Objective 1: To determine the content validity of the sensory integration screening instrument.

A content validity study was done as part of the validation process of the SASISI. The results for this objective will be discussed under 6.4.1.

6.4.1.1 Description of the sample population for content validity

Lynn (1986) proposed that a minimum of three to ten experts were needed to reach appropriate agreement on the items. Using the inclusions criteria as set out in the methodology chapter in 5.4.2.1.1, six occupational therapists were recruited to assist in the content validity. Table 6.51

Table 6.51: Demographic information for the expert panel used for content validity

	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6
Highest qualification	Masters in Occupational Therapy	Masters in Occupational Therapy	M.Sc. in Occupational Therapy	Bachelors in Occupational Therapy	Bachelors in Occupational Therapy	Bachelors in Occupational Therapy
Active Member of SAISI	SAISI Board member	SAISI Board member	SAISI Board member	SAISI Board member	SAISI protocol marker	SAISI protocol marker
Years' OT experience	14 years	23 years	20 years	25 years	9 years	9 years
Years SI experience	12 years	18 years	16 years	19 years	6 years	6 years
Highest level of SI training	Completed full SI training	Completed full SI training	Completed full SI training	Completed full SI training	Completed full SI training	Completed full SI training
SAISI training involved in	SAISI lecturer SAISI protocol marker SAISI Mentor	SAISI lecturer SAISI protocol marker SAISI Mentor	SAISI lecturer SAISI protocol marker SAISI Mentor	SAISI lecturer SAISI protocol marker SAISI Mentor	SAISI protocol marker SAISI Mentor	SAISI protocol marker SAISI Mentor

Half of the panel had a Master's degree in occupational therapy and all were fully trained in sensory integration, with an average of 13 years' experience in sensory integration. All experts on the panel were active members of SAISI and involved in training on SAISI courses, as SAISI protocol markers and SAISI mentors.

6.4.1.2 Results of the content validity

An Item-level content validity index of 0.83 was required to reach a level of significance for a panel of six raters (DeVon et. al., 2007). Table 6.52 reports that all seven activities obtained a score well above 0.83 with total agreement for the star jumps activity. Only two individual items, walking eyes closed on line: use of excessive visual guidance during walking (0.50) and cutting spider task: the child's awareness of the positioning of the body, eyes and legs of the spider (0.66) scored below the expected 0.83 value.

Table 6.52 Results for the Item-level content validity index and Scale-level content validity index (n=6)

Activity	Item-level content validity index (I-CVI)	Scale-level content validity index – average method (S-CVI/Ave)	Scale-level content validity index – universal agreement method (S-CVI/UA)
Dressing (19 items)	0.96	**0.98**	**0.91**
Walking heel-toe (48 items)	0.96		
Star jumps (37 items)	1.00		
Block game (38 items)	0.96		
Clay game (36 items)	0.99		
Cutting spider (33 items)	0.97		
Modulation and organization (24 items)	0.99		
Mean I-CVI	0.98		

The Mean Scale-level content validity index was firstly determined using the mean Item-level content validity index, which were calculated at 0.98 and well above the level of 0.83 (See Table 6.51)

A second score for the Scale-level content validity index was determined using a universal agreement method. This method involved the inclusion of items only with total agreement by the experts, a score of 1.00, which were divided by the total number of items. Two hundred and fourteen items out of a possible 235 reached a total agreement, which resulted in a Universal Scale-level content validity index 0.91, still well above the required 0.83 level of significance.

In summary, these results showed that the content validity for both item and scale-level content validity were above the norm and indicated the items, as well as the scale as a whole, are judged as valid by experts to measure sensory integration domains

6.4.2 Objective 2: To establish concurrent validity by comparing the sensory integration screening instrument against the gold standard, the SIPT measurement.

6.4.2.1 Demographic information on sample

Only 28 children out of the proposed 36 were assessed. This smaller sample was due to variables such as the availability of children and SIPT testers during the set assessment period. Table 6.53 shows that in the Gauteng group of eight children, five were males and three females. In the North West group, 11 of the 20 children were females and nine were males. The final sample consisted of 50% males and 50% females. The largest number of children were from North West Province, because most of the research assistants were from that specific area.

Table 6.53: Male/female distribution in the sample for concurrent validity

	Male	Female	% of total sample
Gauteng (n = 8)	5	3	8 (29%)
North-West province (n = 20)	9	11	20 (71%)

Table 6.54 shows the age distribution of the sample and that 46% of the total sample fell within the 6 year 0 months to 6 years 6 months group, with 29% from group the group of 6 years 7 months to 6 years 11 months. Only 25% of the sample fell between 5 years 0 months and 5 years 11 months, as seen in group 1 and group 2. These age groups are consistent with the children seen in grade one in schools, traditionally the year where children in South Africa start to attend formal schooling.

Table 6.54: The age distribution in the sample for concurrent validity

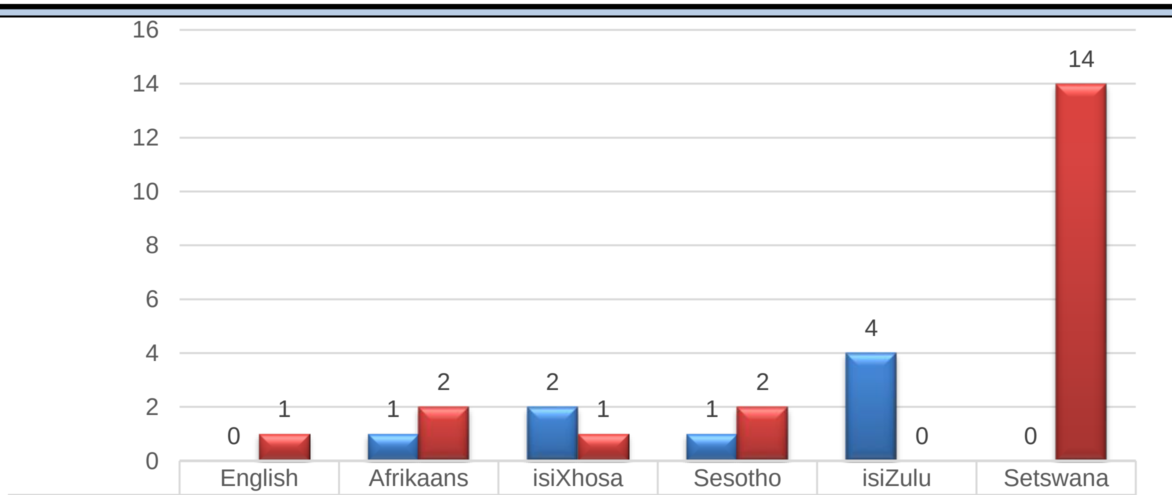
	Males n = 14	**Female n = 14**	**TOTAL**
Group 1 **5 years 0 months to 5 years 6 months**	0	2	**2 (7%)**
Group 2 **5 years 7 months to 5 years 11 months**	3	2	**5 (18%)**
Group 3 **6 years 0 months to 6 years 6 months**	8	5	**13 (46%)**
Group 4 **6 years 7 months to 6 years 11 months**	3	5	**8 (29%)**

In both Gauteng and North West Province, 88% and 90% of the sample, respectively, consisted of children from Black communities, as described in Table 6.55, 12% in Gauteng and 10% in North West Province were children from White communities; no children from Coloured or Indian communities were included. This sample consisted mostly of children from Black communities and this is consistent with statistics published by Statistics South Africa (2012a), indicating that 60.3% of Black children live under the upper poverty line.

Table 6.55: The cultural distribution of the sample for concurrent validity

	Black	White	Coloured	Indian
Gauteng (n = 8)	7 (88%)	1 (12%)	0	0
North west province (n = 20)	18 (90%)	2 (10%)	0	0

It was important to determine the language distribution of the sample as home language influenced the choice of instruction for administration of the SIPT and SASISI instruments. The largest group, consisting of 14 out of the 20 children from North West Province spoke Setswana as a home language, followed by four participants speaking isiZulu (in Gauteng) and three children speaking either Afrikaans, isiXhosa or Sesotho (see Figure 6.25).



	English	Afrikaans	isiXhosa	Sesotho	isiZulu	Setswana
Gauteng n=8	0	1	2	1	4	0
NWP n= 20	1	2	1	2	0	14

Figure 6.25: Language distribution of sample population for concurrent validity

An adapted version of the HESSI questionnaire was used to collect information from the caregivers. Data were analysed in terms of frequencies to summarise the information and compared between the children from Soweto (Gauteng) and Potchefstroom (North West province). One participant did not provide adequate background information to be included in the analysis.

Table 6.56: Comparing the differences in family structure and social status between the Soweto and Potchefstroom environments for concurrent validity testing

Family structure and social status	SOWETO n = 8	POTCHEFSTROOM n = 19
Primary caregiver	**n (%)**	**n (%)**
Mother	6 (75%)	11 (58%)
Both parents	2 (25%)	7 (37%)
Grandmother	0 (0%)	1 (5%)
Grandfather	0 (0%)	0 (0%)
Aunt/Uncle	0 (0%)	0 (0%)
Siblings	0 (0%)	0 (0%)
Father	0 (0%)	0 (0%)
Other	0 (0%)	0 (0%)
Income provider	**n (%)**	**n (%)**
Mother	6 (75%)	8 (42%)
Father	2 (25%)	7 (37%)
Grandparents	0 (0%)	3 (15%)
State pension	0 (0%)	0 (0%)
Other Family (sibling/aunt/uncle)	0 (0%)	1 (6%)
Marital status mother	**n (%)**	**n (%)**
Never married & not living with a	3 (37.5%)	8 (42%)
partner	0 (0%)	5 (26%)
Never married & living with a partner	3 (37.5%)	1 (6%)
Married & not living with partner	2 (25%)	5 (26%)
Married & living with partner		
Education Mother	**n (%)**	**n (%)**
Less than grade 5	0 (0%)	3 (15%)
Primary school (Grade 6 & 7)	2 (25%)	2 (11%)
Junior secondary (Grade 8 & 9)	0 (0%)	2 (11%)
Senior secondary (Grade 10 & 11)	4 (50%)	7 (37%)
Matric/Vocational training	2 (25%)	3 (15%)
College/University	0 (0%)	2 (11%)
Other training	0 (0%)	0 (0%)

As with the results in Phase two, the background information compiled in Table 6.56 shows that in both areas, most of the sample lived with their mothers as the primary caregivers. Only 25% of children in Soweto lived with both parents, and 37% in Potchefstroom.

The mother was the main provider for the family in both areas although in Potchefstroom, the father, grandparents and other family contributed to the household income. Again, a sizable percentage of mothers was never married and did not live with a partner. In Soweto most of the mother's education was found to be at senior secondary level, with two parents who only completed primary school. In Potchefstroom, the mothers' education ranged from less than grade 5 to college level, with the average level of education on a secondary level the same as Soweto. Table 6.57 shows that In Soweto and Potchefstroom most participants lived in informal housing of which they were the owners. Equivalent to the demographics for the sample in Phase two, the children in Soweto lived in a two-room house with an average of 5.3 people residing in the house. At least 75% of households had a separate kitchen and bathroom and 50% had an inside toilet. The participants in Potchefstroom lived in very similar circumstances, in a two to three-room house with an average of 5.5 people living together.

Table 6.57: Comparing the access to household resources and neighbourhood access between the Soweto and Potchefstroom environments for concurrent validity testing

Type of Housing	SOWETO n = 8	POTCHEFSTROOM n = 19
Homeless	0 (0.0%)	0 (0.0%)
Shack/informal housing	4 (50%)	7 (37%)
Hostel	0 (0.0%)	0 (0.0%)
Room/garage	1 (12.5%)	4 (21%)
Flat	0 (0.0%)	0 (0%)
Home share with another family	1 (12.5%)	4 (21%)
Own home	2 (25%)	4 (21%)
Amenities available	**% population**	**% population**
Average number of rooms in dwelling	2 rooms	2 – 3 rooms
Average number of people living in dwelling	5.3	5.5
% of Homes with separate kitchen	75%	95%
% of Homes with separate bathroom	75%	89%
% of Homes with toilet inside house	50%	53%
% of Homes own a refrigerator	63%	79%
% of Homes own a television	100%	79%
% of Homes own a DVD player	25%	32%
% of Homes own a washing machine	38%	68%
% of Homes own a microwave oven	75%	68%
% of families own a telephone	50%	32%
% of Families own a car	38%	21%
Caregiver perception of safety of neighbourhood	**n (%)**	**n (%)**
% of caregivers feel neighbourhood safe	7 (88%)	15 (79%)
% of caregiver who worry often/all the time about child safety outside house.	5 (62%)	7 (37%)

A larger percentage of households had a separate kitchen (95%) and a separate bathroom (89%), with 53% having an inside toilet. The sample for this phase had access to luxury items, such as a TV, refrigerators, microwave ovens and washing machines, but only 50% of families in Soweto and 32% of families in Potchefstroom owned a telephone. Only a few families in Soweto (38%) and 21% in Potchefstroom owned their own car, which suggests the majority either used public transport or walked to school and work. Although 88% (Soweto) and 79% (Potchefstroom) of parents perceived their neighbourhood as safe, it was found that they do feel worried about their child's safety outside the house. This was highest in Soweto (62%) compared to 37% in Potchefstroom.

6.4.2.1.1 Teacher questionnaire

The teacher questionnaire provided information on the child's level of functioning in the classroom and playgrounds that could be an indication of sensory integration difficulties. Table 6.57 gives a visual representation of the percentage of children that functioned on each level for classroom behaviours. A score of four and above indicated a level of classroom functioning that is on par with children of a similar age or even better. A score of three and below indicated the child experienced more difficulty than other children of the same age or needed more assistance. The data for the questionnaire were analysed in terms of the percentage of children obtaining a score on each level of scoring. The aim of the teacher questionnaire was to investigate the overall functioning of the child population for classroom behaviour.

The teacher's questionnaire was developed to get more information from the teacher on the child's behaviours and ability to learn compared to other children of the same age. In Phase two, where a typical sample of children were assessed, the results of the teachers' questionnaire were normally distributed which fitted with a typical sample. In Phase three, the percentage of children rated below a score of 4, the same as other children of the same age was only 28.6% of the sample, whereas 67.8% of the sample were rated as needing more assistance. Looking at individual behaviours in class, Table 6.58 shows the sample did not have much difficulty with turn taking and interaction with peers.

Table 6.58: The teachers' feedback in % on the school behaviours of children within the sample for concurrent validity testing

SCORE	1	2	3	4	5	
DESCRIPTION	Finds it much more difficult than other children of the same age. Needs much more physical assistance and prompting than others.	Finds it more difficult than other children of the same age. Needs more physical assistance, more than others.	Finds it slightly more difficult than other children of the same age. Needs more verbal prompting than others.	The same as other children of the same age.	Performs better than other children of the same age.	TOTAL
	%	%	%	%	%	%
Initiation of a task	14.3	7.1	39.3	39.3	0	100
Completion of tasks	17.9	10.7	28.6	39.2	3.6	100
Problem solving	14.3	17.9	35.7	28.6	3.6	100
Organisation of work	17.9	3.6	42.9	32.1	3.6	100
Work speed	25	0	42.9	32.1	0	100
Follow of instructions	3.6	21.4	57.1	17.9	0	100
Concentration in class	17.9	7.1	46.4	25	3.6	100
Turn taking	3.6	3.6	46.4	35.7	10.7	100
Interaction with peers	3.6	10.7	21.4	46.4	17.9	100
Fine motor skills	0	17.9	53.6	25	3.6	100
Gross motor skills	0	10.7	57.1	25	7.1	100
Balance	0	10.7	57.1	28.6	3.6	100
Coordination	0	14.3	50	32.1	3.6	100
Manages emotions	0	14.3	57.1	28.6	0	100
Behaviour	7.1	7.1	57.1	25	3.6	100

* All scores are recorded in percentages (%)

A percentage of children, > 25% of the sample, however, obtained a score of 1 or 2 for completion of tasks, problem solving, follow of instruction, and concentration in class and work speed. These behaviours are consistent with the behaviours observed in children with sensory integration difficulties (Ayres, 2005).

6.4.2.2 Results of concurrent validity testing

The methodology for determining the concurrent validity testing involved determining the mean Z-scores through descriptive analysis for the SASISI domains as well as the SIPT tests. Table 6.59 presents the mean Z-scores for the SASISI.

Table 6.59: Descriptive statistics for the SASISI n = 28

Domains	Descriptive Statistics (SASISI Stats) Valid N	Mean	Confidence -95.000%	Confidence 95.000%	Minimum	Maximum	Std.Dev.
Sensory perception	28.00	-0.48	-0.82	-0.14	-2.45	1.17	0.87
Postural Ocular control	28.00	-0.46	-0.75	-0.18	-1.57	1.07	0.75
Skills: Bilateral integration & sequencing	28.00	-0.17	-0.45	0.11	-1.50	1.56	0.72
Praxis	28.00	-0.42	-0.70	-0.14	-2.26	1.00	0.72
Handling Objects	28.00	-0.03	-0.32	0.26	-2.20	1.21	0.75
Visual form and space	28.00	0.10	-0.24	0.44	-2.44	1.64	0.87
Sensory reactivity	28.00	0.00	-0.39	0.40	-1.44	1.80	1.02
Organisation of self and environment	28.00	-0.00	-0.40	0.39	-1.14	2.25	1.02
Organisation of self and behaviour	28.00	0.00	-0.39	0.40	-1.40	2.52	1.02

The results for descriptive results of the SASISI are displayed in Table 6.59. Z-scores were used to enable comparison with the SIPT tests. The lowest mean scores were in the domains of sensory perception (-0.48), postural ocular (-0.46) and praxis (-0.42).

Table 6.60 shows the mean Z-scores for the SIPT, as well as the percentage of the sample having trouble within the specific tests. The cut off point for difficulties in the SIPT is set at -1.0SD, with scores lower than -0.80SD as borderline difficulties.

Table 6.60 shows that scores of below -1.0SD were obtained for the manual form perception test (-1.33SD), finger identification test (-1.10SD), graphesthesia test (1-.14 SD), praxis on verbal command test (-2.62SD), design copying test (-1.51SD) and the constructional praxis test (-1.22SD). Borderline scores were seen in the space visualisation test (-0.96SD), figure ground test (-0.95SD) and kinaesthesia test (-0.85SD).

Table 6.60: Descriptive statistics for the SIPT test n=28

Domain	Descriptive Statistics (Descriptive stats SIPT analysis.sta)							
	Valid N	Mean	Confidence -95.000%	Confidence 95.000%	Minimum	Maximum	Std.Dev.	% sample experience difficulty
SV	28	**-0.96**	-1.22	-0.69	-2.71	0.09	0.69	**50%**
FG	28	**-0.95**	-1.31	-0.60	-2.70	1.29	0.91	**50%**
MFP	28	**-1.33**	-1.87	-0.79	-3.00	0.92	1.39	**57%**
KIN	28	**-0.85**	-1.33	-0.36	-3.00	0.94	1.25	39%
FI	28	**-1.10**	-1.63	-0.57	-3.00	1.49	1.37	**54%**
GRA	28	**-1.14**	-1.58	-0.70	-2.87	0.99	1.13	**61%**
LTS	28	-0.33	-0.89	0.23	-3.00	2.14	1.44	32%
PrVc	28	**-2.62**	-2.87	-2.36	-3.00	-0.83	0.66	**96%**
DC	28	**-1.51**	-1.97	-1.06	-3.00	1.10	1.17	**71%**
CPr	28	**-1.22**	-1.57	-0.86	-2.78	0.46	0.92	**57%**
PPr	28	-0.22	-0.58	0.14	-2.63	1.11	0.93	25%
Opr	28	-0.39	-0.72	-0.05	-1.86	1.34	0.87	29%
SPr	28	-0.48	-0.85	-0.11	-1.95	2.55	0.95	29%
BMC	28	-0.21	-0.69	0.26	-2.39	2.56	1.23	32%
SWB	28	-0.57	-1.01	-0.13	-2.97	1.69	1.13	25%
MAC	28	-0.77	-1.36	-0.17	-3.00	3.00	1.54	43%
PRN	28	-0.35	-0.71	0.01	-1.55	1.77	0.93	46%

**** Below -1 SD problematic scores   ** -0.80 to – 0.99 Borderline problematic scores   -0.80 and above typical scores*

Table 6.61 provides a visual representation of the correlations between the SASISI and SIPT, based on the Spearman's rank order correlation coefficient. Correlations were based on the description by Tomita (2006), namely 0 to 0.29 shows no correlation, 0.30 to 0.39 a weak correlation, 0.40 to 0.59 a moderate correlation, 0.60 to 0.79 a strong correlation and 0.80 to 1.00 an excellent correlation. Significance was set at $p > 0.05$.

The sensory perception domain of the SASISI showed a moderate correlation with a significant relationship ($r_s = 0.42$, $p = 0.02$) with the space visualisation test of the SIPT. A weak correlation ($r_s = 0.31$) was found between sensory discrimination and localisation of finger touching of the SIPT although the significance of the relationship was poor ($p = 0.11$).

The postural ocular domain showed a moderate meaningful relationship with space visualisation from the SIPT ($r_s = 0.46$, $p = 0.01$), but showed a moderate negative significant correlation with the praxis on verbal command test of the SIPT ($r_s = -0.44$, $p = 0.02$).

The bilateral integration and sequencing domain showed a significant moderate correlation with space visualisation from the SIPT ($r_s = 0.49$, $p = 0.01$). Weak correlations were also found with sequencing praxis, bilateral motor coordination and post-rotary nystagmus.

A similar significant moderate correlation was found between the praxis domain and space visualisation ($r_s = 0.49$, $p = 0.01$) and a weak correlation with post-rotary nystagmus ($r_s = 0.31$). A weak correlation was found with localisation of touch ($r_s = 0.32$) and a negative weak correlation with graphesthesia ($r_s = -.036$). The handling of objects domain only had weak correlations with space visualisation ($r_s = 0.32$) and bilateral motor coordination ($r_s = 0.37$), although no significance was found.

The visual form and space domain showed some relationships with eight of the SIPT subtests. Moderate significant correlations were found with space visualisation ($r_s = 0.53$, $p = 0.00$) and oral praxis ($r_s = 0.56$, $p = 0.00$). Weak correlations, with no significance, were found with manual form perception ($r_s = 0.34$), postural praxis ($r_s = 0.34$), sequencing praxis ($r_s = 0.30$), bilateral motor coordination ($r_s = 0.33$) and post-rotary nystagmus ($r_s = 0.30$). A weak negative correlation was found between the visual form and space domain and graphesthesia ($r_s = -0.33$).

Praxis on verbal command showed a moderate significant correlation with the sensory modulation domain ($r_s = 0.42$, $p = 0.03$). A weak correlation was also found between figure ground and sensory modulation. A moderate significant negative correlation was found between sensory modulation and post-rotary nystagmus ($r_s = -0.48$, $p =0.01$) and a weak negative correlation with sequencing praxis.

Organisation of the space and environment showed a weak negative significant correlation with localisation of touch ($r_s = -0.38$) and a weak positive correlation with praxis on verbal command ($r_s = 0.35$). Organisation of self and behaviour showed a positive moderate significant correlation with praxis on verbal command ($r_s = 0.42$, $p = 0.02$) and a weak correlation with figure ground ($r_s = 0.31$). A significant weak negative correlation was found between organisation of behaviour and motor accuracy test ($r_s = -0.37$, $p = 0.05$) and weak negative correlations with localisation of touch ($r_s = -0.34$) and post-rotary nystagmus ($r_s = 0.31$).

In summary, these results showed that several significant correlations were found between the SASISI and SIPT, but these were not as strong as suspected. The moderate significant correlations between space visualisation and sensory perception, postural ocular control, bilateral integration and sequencing and visual form and space, as well as oral praxis and visual form and space, in addition to praxis on verbal command and sensory reactivity and organisation of self and behaviour suggests there are relationships between these items and domains. Although more development of the items is needed, this is a positive sign that the domains are measuring sensory integration constructs.

Table 6.61: Spearman's rank order correlation coefficient for comparing the SASISI and SIPT

Spearman Rank Order Correlations (MASTER SHEET SCORES Phase 3 Analysis.sta)
MD pairwise deleted
Marked correlations are significant at p <.05000

Variable	Sensory Perception Spearman R	p-value	Postural Ocular control Spearman R	p-value	Skills: Bilateral integration Spearman R	p-value	Praxis Spearman R	p-value	Object Handling Spearman R	p-value	Skills: Visual form and space Spearman R	p-value	Sensory reactivity Spearman R	p-value	Organization of space and environment Spearman R	p-value	Organization of self & behaviour Spearman R	p-value
SV	**0.45**	0.02	**0.46**	0.01	**0.49**	0.01	**0.49**	0.01	**0.32**	0.09	**0.53**	0.00	-0.26	0.18	-0.08	0.67	-0.25	0.21
FG	-0.18	0.37	-0.29	0.14	-0.09	0.65	0.04	0.84	0.20	0.30	0.28	0.15	**0.34**	0.07	0.11	0.56	**0.31**	0.11
MFP	-0.18	0.36	**-0.32**	0.10	-0.21	0.27	-0.02	0.90	-0.06	0.78	**0.34**	0.08	0.07	0.71	0.18	0.35	0.13	0.52
KIN	0.08	0.67	-0.06	0.75	-0.03	0.89	-0.04	0.85	-0.13	0.51	0.11	0.57	0.01	0.97	0.09	0.64	-0.13	0.52
FI	-0.05	0.80	-0.10	0.63	0.03	0.87	-0.11	0.58	-0.13	0.51	0.10	0.62	-0.29	0.14	-0.02	0.93	-0.11	0.59
GRA	-0.24	0.23	-0.02	0.91	-0.25	0.20	**-0.36**	0.06	-0.06	0.74	**-0.33**	0.09	-0.17	0.39	-0.07	0.72	-0.24	0.23
LTS	**0.31**	0.11	0.27	0.17	0.23	0.25	**0.32**	0.10	-0.03	0.87	0.25	0.20	-0.21	0.28	**-0.38**	0.05	**-0.34**	0.08
PrVc	-0.23	0.24	**-0.44**	0.02	-0.16	0.42	0.00	0.99	0.23	0.23	0.20	0.30	**0.42**	0.03	**0.35**	0.06	**0.42**	0.02
DC	-0.09	0.66	0.10	0.61	-0.09	0.64	-0.04	0.82	-0.04	0.85	0.14	0.48	-0.28	0.15	-0.29	0.14	-0.26	0.18
CPr	-0.23	0.24	-0.02	0.90	**-0.33**	0.09	-0.22	0.27	-0.05	0.81	-0.11	0.57	0.11	0.57	-0.10	0.60	-0.10	0.60
PPr	0.16	0.43	0.06	0.76	0.14	0.48	-0.01	0.96	-0.16	0.43	**0.34**	0.07	-0.03	0.90	0.07	0.72	-0.11	0.58
Opr	0.26	0.18	0.23	0.24	0.17	0.39	0.22	0.26	0.18	0.35	**0.56**	0.00	0.05	0.82	-0.05	0.81	0.02	0.90
SPr	0.29	0.14	0.27	0.16	**0.37**	0.06	0.22	0.26	0.25	0.21	**0.30**	0.12	**-0.33**	0.09	-0.28	0.15	-0.22	0.26
BMC	0.21	0.28	0.24	0.22	**0.36**	0.06	0.25	0.20	**0.37**	0.06	**0.33**	0.09	-0.10	0.61	-0.17	0.39	-0.21	0.29
SWB	-0.20	0.30	-0.11	0.58	-0.08	0.70	-0.12	0.54	0.12	0.54	-0.02	0.91	-0.19	0.34	-0.01	0.96	-0.21	0.27
MAC	-0.15	0.44	-0.19	0.34	-0.03	0.89	-0.07	0.74	-0.15	0.44	0.11	0.57	-0.07	0.71	-0.31	0.11	**-0.37**	0.05
PRN	0.25	0.20	0.22	0.25	**0.33**	0.08	**0.31**	0.11	0.00	1.00	**0.30**	0.12	**-0.48**	0.01	-0.19	0.34	**-0.31**	0.10

Possitive correlations: 0 - 0.29 no correlation, 0.30 – 0.39 a weak correlation, 0.40 – 0.59 a moderate correlation, 0.60 – 0.79 a strong correlation and 0.80 – 1.00 excellent (Tomita, 2006).
Negative correlations: - 0.29 no negative correlation, 0.30 – 0.39 a weak negative correlation, 0.40 – 0.59 a moderate negative correlation, 0.60 – 0.79 a strong negative correlation and 0.80 – 1.00 excellent negative correlation.

6.4.3 Objective 3: To establish the sensitivity and specificity of the screening instrument.

Sensitivity and specificity, test the validity of an instrument, by measuring the diagnostic accuracy of the instrument to determine typical or atypical functioning (Campo et. al., 2010). Bewick et. al. (2004) proposed that both sensitivity and specificity are needed to be able to discriminate for a diagnosis. Sensitivity determines the probability of an abnormal or positive result or the proportion of individuals with a disease, whereas specificity determines the probability of a normal result or the proportion of individuals without the disease (Trajman and Luiz, 2008). Both are measured in percentages and Friberg (2010) suggested that values of 0.80 or greater are considered appropriate. The positive, as well as negative predictive values were also determined as this gives further information on the probability of the dysfunction when a positive score is obtained or that the dysfunction is not present when the score is negative (Hajian-Tilaki, 2013).

The sensitivity and specificity for the SASISI was determined using a 0.50SD cut-off point and determining the ROC curves. The results of the analysis will be discussed under 6.5.3.

6.4.3.1 Demographic information on sample

The sample was the same sample as discussed in the concurrent validity testing in Objective 2 under point 6.3.2.1.

6.4.2.2 Results of the sensitivity and specificity testing

The sensitivity and specificity of the SASISI was determined through ROC curves analysis using a cut-off value of -0.50 SD and a prevalence rate of 12%. Table 6.62 reports on the findings of the statistical analysis. The results of the ROC analysis indicated a 100 when using a cut-off value of -0.50 for the sensitivity and specificity for all nine of the domains, with the lowest sensitivity for object handling (98.11) and the lowest specificity for sensory perception (99.37) and bilateral integration and sequencing (99.37). The 95% confidence interval for each domain indicates the range of accuracy in determining the sensitivity (Chu, 1999). The handling of objects and bilateral integration and sequencing have the lowest confidence levels of between 89.9 and 100, which indicated that although these tests would identify children with an SI difficulty there is range between less than 89.9% and 100% in the precision with which these difficulties will be correctly identified.

This means these subtests will be able to discriminate between the percentage of children who do and do not have sensory integration difficulties. The receiver operating characteristic (ROC) curves associated with sensitivity and specificity confirmed these findings, with all areas under the ROC curves (AUC) being 0.99 or higher. The closer the AUC score is to 1, the better the diagnostic value of the instrument (Bewick et. al., 2004).

The high scores for both positive predictive values, as well as the negative predictive values further confirmed the sensitivity and specificity of the SASISI. The positive predictor value describes the likelihood of a child having a positive outcome with positive scores, whereas the negative predictive value indicates the chance of having a negative outcome with a negative score (Bewick et. al., 2004). The results of the analysis again show high scores for both predictive values, with the lowest positive predictive value for bilateral integration and sequencing (95.50). The predictive values are however affected by the prevalence of disease and may change as the prevalence changes (Bewick et. al., 2004).

In summary, these results indicated good sensitivity and specificity scores, indicating the subtests ability to discriminate between having sensory integration difficulties or not. High predictive ability scores suggest the high probability of having sensory integration difficulties when obtaining a positive score and a low probability of having sensory integration difficulties with negative scores.

Table 6.62: The sensitivity and specificity for the domains of the SASISI

	Sensory perception (cut off -0.50)	Postural ocular control (cut off -0.50)	Bilateral integration and sequencing (cut off -0.50)	Praxis (cut off -0.50)	Object handling (cut off -0.50)	Visual form and space (cut off -0.50)	Sensory reactivity (cut off -0.50)	Organisation of space and environment (cut off -0.50)	Organisation of self and behaviour (cut off -0.50)
					Percentage (95% Confidence intervals				
Optimal criterion score	**≤ -0.50**	**≤ -0.55**	**≤ -0.50**	**≤ -0.52**	**≤ -0.71**	**≤ -0.51**	**≤ -0.54**	**≤ -0.57**	**≤ -0.53**
Sensitivity	100.00 (94.8 - 100.0)	100.00 (94.9 - 100.0)	98.57 (92.3 - 100.0)	100.00 (94.4 - 100.0)	98.11 (89.9 - 100.0)	100.00 (94.3 - 100.0)	100.00 (94.1 - 100.0)	100.00 (95.9 - 100.0)	100.00 (94.9 - 100.0)
Specificity	99.37 (96.5 – 100.0)	100.00 (97.7 – 100.0)	99.37 (96.5 – 100.0)	100.00 (97.8 – 100.0)	100.00 (97.9 – 100.0)	100.00 (97.8 – 100.0)	99.40 (96.7 – 100.0)	100.00 (97.4 – 100.0)	100.00 (97.7 – 100.0)
Positive predictive value	95.60 (75.4 – 99.4)	100.00	95.50 (75.1 - 99.3)	100.00	100.00	100.00	95.80 (76.3 - 99.4)	100.00	100.00
Negative predictive value	100.00	100.00	98.80 (98.6 - 100.0)	100.00	99.70 (98.2 - 100.0)	100.00	100.00	100.00	100.00
ROC curves area under the ROC curve (AUC)	0.99 (0.98 to 1.00)	1.00 (0.98 to 1.00)	0.98 (0.96 to 0.99)	1.00 (0.98 to 1.00)	0.98 (0.95 to 0.99)	1.00 (0.98 to 1.00)	0.99 (0.98 to 1.00)	1.00 (0.98 to 1.00)	1.00 (0.98 to 1.00)

6.4.4 Summary of the results of Phase Three

Phase three aimed to establish additional psychometric properties of the newly developed SASISI. The results for the content validity demonstrated prominent levels of validity with both item and scale level content validity above 0.90 indicating the use of valid measurement content. The concurrent validity between the SASISI and SIPT tests found moderate significant correlations with space visualisation, sensory perception, postural ocular control, bilateral integration and sequencing, visual form and space, as well as oral praxis. These results are a positive sign for the validity of the SASISI. High levels of sensitivity and specificity were found in all the domains of the SASISI and indicated the instrument would be able to discriminate between children with sensory integration difficulties and those without.

6.5 CONCLUSION OF THE RESULTS

Phase one focused on the development of activities to be used for observations of sensory integration. Objective 1 explored the sensory integration activities for inclusion in the sensory integration screening instrument. A recurrent theme through all the categories was the use of clinical observations and observing a child participating in an activity as an assessment technique. Based on these themes and further investigation of the literature and existing assessments, a questionnaire was developed for the second objective. Objective 2 aimed to obtain consensus on the identified items chosen for inclusion in the screening instrument. Six activities, namely dressing and undressing, walking heel-toe, star jumps, construction with blocks, making clay shapes and cutting with scissors, reached a consensus of 70% and was included in the screening instrument. Following the identification of these activities, Objective 3 focused on the construction of an administration format and scoring system using activity analysis. The results for Objective 3 included describing the test specifications as well as the administration mode, the description of the activity and order of execution, the administration time for each activity and the item response format. The scoring system was developed according to set scoring specifications including the scoring responses as described in Figure 6.6: activity analysis used to determine the scoring. Finally, Objective 4 included the compilation of an administration manual and clinician training programme to guide administration and scoring of the screening instrument. The results for this objective included the description of the administration manual and scoring descriptions, as well as a description of the blended learning training programme for administrators.

The results of each of the four objectives built on each other to produce the screening instrument named the South African Sensory Integration Screening Instrument.

Phase two of the instrument development phase included the validation of the SASISI. Objective 1 focused on the pilot testing of the sensory integration screening instrument to determine any problems with item construction or scoring prior to implementation. The pilot testing identified difficulties in the clarity of the instructions, the language used for instruction, the clarity of the scoring guidelines and the change to the clay activity and spider cutting activity. The difficulties were addressed and adapted prior to the start of establishing the construct validity of the SASISI in Objective 2 of this phase. Analysis of the demographic area, where the sample for construct validity lived, indicated severe poverty in all three areas with very few resources. Age and gender for the sample was evenly spread between boys and girls, as well as the age groups. Children spoke various languages, with Zulu being the most prevalent in Soweto and Alexandra and Tswana in Potchefstroom. The HESSI questionnaire provided some information regarding where they lived, who the caregiver was and where their income came from. The mothers were the main caregiver and breadwinner in the family, with very little input from the fathers. The mothers living in Soweto had a higher level of education than those from Alexandra and Potchefstroom.

The construct validity of the SASISI was determined using the Rasch model. The results indicated that although all nine domains of the SASISI were unable to obtain mean item fit residual scores close to 0.00, the scores still fell within the ± 2.5 range. Only the Chi-square scores for bilateral integration and handling of objects were not significant and therefore fitted the Rach model. Residual correlations only showed local dependency in the organisation of self and behaviour domain. Although no domain showed good reliability, as described in the person separation index, the scores were within reach of the >0.85 level of acceptability. The handling of objects, sensory reactivity, organisation of self and environment and organisation of self and behaviour domains were the only ones that reached uni-dimensionality and adhered to the criteria of the Rasch model. Although none of the domains adhered to all the criteria for the Rasch model, the results are promising in terms of the SASISI measuring the underlying constructs of sensory integration.

Objective 3 of Phase two attempted to establish the clinical utility of the newly developed sensory integration screening instrument, e.g. appropriateness for use and difficulties with administration and scoring. Thematic analysis of the individual interviews with the research assistants established five themes on the usefulness of the instrument, namely instrument design, instructions, administrative procedures, use of activates for measurement and scoring. The findings of the thematic analysis guided the refinement of the SASISI, as described in Phase two.

Phase three aimed to establish additional psychometric properties of the newly developed SASISI. The content validity of the sensory integration screening instrument was determined in Objective 1 and the results concluded that the content of items, as well as the overall scale, were high and therefore valid for use to determine sensory integration difficulties. This objective was followed by establishing the concurrent validity by comparing the sensory integration screening instrument against the gold standard, the SIPT. Significant moderate correlations were found between some domains in the SASISI and SIPT subtests. Although the correlations were not high, the moderate correlations were positive in that it showed there were some relationships between the two tests. Objective 3 aimed to establish sensitivity and specificity of the sensory integration screening instrument. The sensitivity and specificity of the SASISI were high, and ranged between 59.0 and 100 for sensitivity and 66.1 and 100 for specificity. Cut-off points were established for each domain of the SASISI at the points where the sensitivity and specificity were balanced.

In conclusion, the results indicated the screening instrument developed in Phase one showed provisional validity for screening for sensory integration difficulties despite the small sample size. This is promising for the future development of the SASISI.

CHAPTER 7: DISCUSSION OF RESULTS

7.1 INTRODUCTION

The study set out to determine if a contextually appropriate screening instrument would provide a tool that can guide the identification of children from low socio-economic communities who are at risk of having sensory integration difficulties. Limited research is available on the influence of low socio-economic environments on sensory integration in a South African context. One aspect that plays a role in the lack of research is the use of appropriate and valid assessment tools.

The literature review on test development guidelines revealed that an exact test design plan was not available, and that the actual steps followed differ depending on which theoretical foundation it was developed from, e.g. a psychological, educational, healthcare or occupational therapy theoretical foundation. A content analysis of literature on instrument development was done prior to the study to determine the criteria that guided the phases of the study. A set of criteria, as can be seen in Table 4.3, was developed to guide the development of a new screening instrument. These criteria included the purpose of the instrument, the intended population, the cultural context for the instrument, item development and scoring, administrative requirements and the psychometric soundness of the instrument. The test design plan for this study included these criteria by identifying the aim or purpose of the instrument, the intended population, determining the behaviours or construct to be measured, generating items to measure the construct considering the cultural context, developing the administrative and scoring formats, and investigating psychometrics of the instrument, were used in this study.

The discussion will review the findings of the objectives for each of the three phases. Discussion of Phase one will include the process that was followed to develop the activities, as well as the activity analysis process that was used to develop activities for administration and scoring to measure the observations. The discussion for Phase two will include the specific low socio-economic population that was used for the validation of the instrument, as well as the psychometric testing of the instrument that was done to determine the internal construct validity. The outcomes of the psychometric testing in Phase three namely, the content validity, the concurrent validity and the sensitivity and specificity will finally be addressed.

7.2. DISCUSSION OF RESULTS OF PHASE ONE

The literature review described a screening tool as a short, cost effective tool that provides a comprehensive view of a child's functioning (Bédard and Dickerson, 2014). The first phase aimed to develop the items for the screening instrument identifying sensory integration difficulties in children aged 5 years 0 months to 6 years 11 months, from low socio-economic environments. Four objectives were set to identify six activities for the SASISI and to develop these activities using activity analysis into specific tasks and measurable actions. Finally, the administrative and scoring format was developed and described in the administrative manual that subsequently led to the development of training programme for occupational therapists.

7.2.1 Objectives 1 and 2 using the Delphi process to develop activities for the SASISI

Objectives 1 and 2 for Phase one were completed successfully as an expert panel in sensory integration identified observations deemed important in assessment and reached consensus on the inclusion of six activities in the SASISI.

The first objective focused on the qualitative exploration of the activities that could be used as items for the measuring of sensory integration difficulties in low socio-economic environments. This was done using the Delphi process and an open-ended questionnaire to explore experts in view on the sensory integration activities for inclusion in the screening instrument. The experts who were invited to participate in the first round of the Delphi process were purposively chosen for their extensive knowledge on sensory integration. This method was chosen rather than focus groups as experts in sensory integration are spread out throughout South Africa, which made the use of focus groups problematic. The response rate of 17% was low and a possible explanation for this might be that the questionnaire was sent out at the end of a school year when occupational therapists are overwhelmed with completing therapy sessions before the holidays and writing progress reports. The results in Table 6.1 and Figure 6.1 showed that although the group of experts had a wide variety in years of experience, at least 83% were involved in mentoring or training other occupational therapists in sensory integration. The researcher therefore felt confident that the information provided by the expert's was based on sound sensory itnegration knowledge.

Thematic analysis was used to investigate the findings that were gathered. The findings of the analysis, as described in 6.2.1.2 in Chapter 6, suggested an overall theme of the use of clinical observations for assessment.

Clinical observations are important for inclusion in a screening instrument for children living in low socio-economic environments. This finding corresponds to the recommendations by Thorley and Lim (2011), that observations of the child engaged in a task may provide valuable information on skills without having to rely on expensive equipment or the language used for instructions. The thematic analysis generated some activities for inclusion in the screening instrument, as can be seen in Table 6.2, but there were not enough activities to inform the quantitative data collection for Objective 2. A possible explanation for this could be the fact that the experts focused on the observations of activities rather than providing specific activities for use.

The above findings informed the quantitative data collection for the second objective, which focused on reaching consensus on the activities for inclusion in the screening instrument. As the Delphi process in the first objective did not generate a wide selection of activities, the researcher identified a variety of activities from the literature, as described in Table 6.3. A quantitative questionnaire was developed for the second round of the Delphi process. This question incorporated the feedback from the qualitative thematic analysis in the first round, as well as activities that were identified in the literature, as seen in Table 6.3. By including activities from both processes, the researcher aimed to widen the selection of activities for the expert panel. The response rate improved to 84% for Objective 2 and finally six activities were identified with a 70% consensus rate between the experts; these activities included getting dressed and undressed, walking heel-toe on a line, star jumps, building a block construction, making clay shapes and cutting with scissors. Similar activities were found in other standardised assessments by occupational therapists, although they were not necessarily used to describe sensory integration difficulties. These assessments are discussed below.

Dressing and undressing is an assessment activity frequently used to determine a child's developmental level. Assessments such as the Ages and Stages questionnaire (Singh et. al., 2017) and the Developmental Assessment of Young Children (DAYC) are global screening instruments that include the task of dressing and undressing to determine a child's functional ability to complete the task at a specific developmental age. Other instruments, such as the Paediatric Evaluation of Disability Inventory (PEDI) (Haley, 1992) and the Functional Independence Measure for Children (WEEFIM) (Hamilton and Granger, 1991), also include dressing and undressing tasks to determine the child's performance on different levels of dependence. None of these assessments however judges the child's ability to process and integrate sensory input. Children with sensory integration difficulties traditionally have difficulties in executing dressing tasks, as confirmed by Armstrong et. al. (2013) and Koenig and Rudney (2010), and observing this task will provide information on this.

Not only will this activity provide information on the child's sensory perception, body awareness and motor skills, such as postural reactions, bilateral integration and praxis, but also on their tactile reactivity (Koenig and Rudney, 2010).

Several standardised assessments such as the Movement assessment Battery for Children (MABC) 2nd edition and the SAISI gross motor clinical observations include the walking heel-toe activity as a measure of balance. The MABC-2 has a balance item for walking heel-toe forward for children aged 7 to 10 years and walking heel-toe backwards for children age 11 to 16 years (Henderson et. al., 2007). The aim of the walking heel-toe items is to investigate the task demands on the child's ability to balance and appropriate movement patterns. The scoring system of the MABC is based on the highest number of correct steps on a 4.5m line and the child's ability to walk heel-toe without leaving spaces between feet, falling off the line, or readjusting their balance. Within the above-mentioned assessments, the assessment of walking heel-toe was not developed to determine sensory integration difficulties, but rather the identification of motor difficulties. This activity was however, included in the SIPT test as one of the test items for Standing and Walking Balance (SWB) (Ayres, 1989), as it provided valuable information on vestibular processing (Ottenbacher and Degraft, 2013). Walking heel-toe was similarly included in the SAISI gross motor clinical observations, that are based on the Ayres clinical observations (Cook et. al., 2004). Psychometric testing of the SIPT found that the SWB test showed positive relationships with other assessments tapping into proprioception, as well as bilateral integration and sequencing, visuopraxis and somatopraxis (Ayres, 1989). Ayres (1989) found in early research of sensory integration that the walking heel-toe activity discriminated well between typical children and children with dysfunction.

Star jumps or jumping jacks provide valuable information on the child's ability to coordinate the two-sides of their bodies, coordinated movements and postural movements, bilateral integration and sequencing and endurance. Bundy et. al. (2002) proposed that age appropriate star jumps or jumping jacks are the more reliable assessments to provide information on bilateral integration and projected action sequences. The authors explained it provides information on the ability of the two sides of the body to work in a coordinated manner. Difficulty initiating jumping with both feet together, to follow a specified sequence and to stop within the sequence provides information on projected action sequences (Bundy et. al., 2002). Projected action sequences are traditionally assessed using activities that involve the bouncing of a ball, but as no ball activities were selected for the SASISI, the star jumps activity and the jumping of a specific sequence during the activity will provide information on projected action sequences.

The building of blocks is frequently included in standardised assessments, such as the Miller Assessment for Pre-schoolers (Miller, 1988), the MABC (Henderson et. al., 2007), the Griffiths (Luiz et. al., 2006) and the Early Childhood Developmental Criteria (Herbst and Huysamen, 2000). Observations on the ability to plan a block design, spatial orientation of the block design, grip and manipulation of the block can be made. The use of construction tasks with blocks provide valuable information on the child's visual-motor integration skills, visual spatial skills, praxis, manual dexterity and upper limb coordination (Cermak and Murray, 1991; Wilson et. al., 1995). Ayres (1989) developed the constructional praxis test for the SIPT to measure the child's ability to relate objects to each other using the assembly of 3D and 2D tasks. The constructional praxis test correlated highly with the other praxis tests in the SIPT and (Ayres, 2004) found that three dimensional constructions do not only include visual space perception, but also visuopraxis factors. Again, this provides information on their tactile discrimination as well as reactivity and visual form and space (their ability to produce a shape).

The client's reactivity to clay is frequently included in questionnaires for sensory modulation (Blanche et. al., 2014; Bar-Shalita et. al., 2009; Parham et. al., 2007; Rosenblum, 2006), but little has been written on the use of clay for assessment of motor skills. Drawing a pattern on the back of the child's hand is similar to the graphesthesia test included in the SIPT and provides valuable information on the child's ability to discriminate tactile information. Ayres (2004) found that graphesthesia is loaded with somatopraxis factors and showed a relationship with bilateral integration and sequencing.

Cutting with scissors is a performance skill that children in South Africa are exposed to in grade R or grade one at school. Ratcliff et. al. (2011) used a specific observation form to determine a child's cutting skills and found that the motor components of cutting is not completely mature at age 6 years in grade 1. This finding from the above study was considered in the development of the cutting activity but the focus is on the child's approach and attempt of the task rather than the competency. Herbst and Huysamen (2000) included cutting in the development of the Early Childhood Developmental Criteria that is specifically for children from low socio-economic environments. The cutting assessment in this instrument was based on existing instruments. McAtee and Mack (1990) and Koenig and Rudney (2010) found that children with sensory integration difficulties frequently find it hard to cut with scissors. The MFUN (Miller, 2006) and Movement ABC (Henderson et. al., 2007) are two of the assessments that included cutting tasks as items within the tests. Limited information, if any, is however available on the specific aspects of scissor skills that need to be measured or the norms for different ages for children from low socio-economic environments.

7.2.2. Objective 3: Construction of the administration format and scoring system

Objective 3 for Phase one focused on the construction of the administration and scoring format for the SASISI. The activity analysis, as described in the OTPFIII, was used with success to guide the breakdown of activities by describing how the activity is executed, the meaning for the child, cultural appropriateness and tools and resources needed. The activity analysis process further ensured that the development of the SASISI adhered to the instrument development criteria in the South African context, as set out in the content analysis.

The intended population for the SASISI is children aged 5 years 0 months to 6 years 11 months from low socio-economic environments and the execution of the activities needed to reflect this, which had to be age appropriate for both boys and girls. The dressing and undressing task is age appropriate as children between the age of 5 years and 6 years 11 months are expected to be able to put on and take of a garment independently. The clinical observations for gross motor items advised that children between 4 years 0 months and 10 years 11 months were unable to complete the task walking offline, which guided the researcher to administer the activity on a line (Cook et. al., 2004). Guidelines on the administration of the star jumps were also based on the clinical observations of gross motor items and therefore the children were only expected to jump with arms to shoulder height for this specific age group. The types of patterns and difficulty level of the construction of blocks patterns were based on the cube test of the Gesell Preschool Test (Haines et. al., 1980). The researcher focused more on the visual form and space aspect of the construction with blocks as the literature review indicated links between the vestibular system and spatial orientation (Hitier et. al., 2014), as well as visual perceptual difficulties in children from low socio-economic environments (Pienaar et. al., 2014). The clay activity was not based on age norms, although children of all ages enjoy playing with clay, but was developed in such a way that it provided information on the child's tactile discrimination and sensory reactivity. The picture of a spider was chosen specifically for the cutting activity as it includes cutting in a square, straight line and a circle, as children aged 5 years and older are able to cut more complex shapes (Folio and Fewell, 2000). As Ratcliff et. al. (2011) found that South African children at the age of 6 years still have immature motor components of cutting, the administration of this activity focused more on attempt than accuracy. By ensuring the activities were age appropriate and that the execution thereof were meaningful to the child, it was found that children enjoyed the activities and that they were more motivated to participate. Another important finding of the activity analysis was that these age appropriate activities link well with the purpose of the SASISI.

The purpose of the SASISI is to determine if children from low socio-economic environments are at risk of having sensory integration difficulties. Services for children from low socio-economic environments are provided within public or rural healthcare settings although these services are severely hampered by a shortage of staff (Gray and Gray, 2017). A screening instrument that takes less than an hour to administer or that can be completed in one visit is therefore ideal for use in these settings. The administration of the six activities of the SASISI was developed in such a way that the execution takes between five to 15 minutes to complete. The cutting activity took the longest to administer because it also included colouring in, cutting with scissors, as well as pasting the parts together. The researcher did however notice that as the children can take the end-product home, they tend to spend a lot of time completing the activity to ensure the quality of colouring in and cutting is more accurate. No time components were set for the execution of the tasks except for the star jumps, where the child is asked to jump as quickly as possible within 15 seconds. The research assistants suggested in the interviews in Objective 3 in Phase two to add time limits, but the researcher decided against this after considering recommendation by Herbst and Huysamen (2000). These authors believe that by allowing children from low socio-economic environments to complete a task at their own pace, they will be able to perform to their potential (Herbst and Huysamen, 2000).

The occupational therapy services in public or rural healthcare settings are mainly provided by community service occupational therapists (National Department of Health, 1997). Community occupational therapists are not trained in sensory integration as it is a postgraduate course, yet they need to identify these children in the community. The administration and scoring format for the SASISI had to consider the community occupational therapists basic knowledge of sensory integration yet provide them with the information to identify children at risk. As Thorley and Lim (2011) proposed that observations of performance tasks are more appropriate for children from diverse cultures and considering a similarity by the expert panel in sensory integration in Objective 1 Phase one to use clinical observations to guide the administration format, observations were chosen as the administration format. Each activity was broken into steps, which were further broken down into observable actions. This was not a new format for occupational therapy assessments, as a similar process was used by Fisher and Jones (2010) in the Assessment of Motor and Performance Skills (AMPS) and the School version of the Assessment of Motor and Process Skills (Fisher et. al., 2002).

Each observable action linked to nine domains of sensory integration were derived from the sensory integration literature and used to guide the clarification of the sensory integration difficulties.

The researcher reasoned that by providing the occupational therapists administering the SASISI with observations and specific sensory behaviours linked to these observations, it would guide the scoring and the subsequent identification of sensory integration difficulties. These domains were found to be similar to the domains identified for the Evaluation in Ayres Sensory Integration® (EASI®), namely Sensory Perception, Praxis, Ocular, Postural, and Bilateral Motor Integration and Sensory Reactivity (Mailloux et. al., 2018). This finding was positive as it confirmed that the domains identified for the SASISI were in line with current sensory integration theory.

The EASI® further aims to provide an assessment that includes inexpensive equipment and short and easy instructions (Mailloux et. al., 2018). Similar criteria were used in the development of the SASISI. The use of culturally appropriate activities worked well as the administration of the activities were done in such a way that it required minimum or low-cost equipment and minimum verbal instructions. Herbst and Huysamen (2000) recommended that culturally appropriate activities and equipment were essential for assessments in low socio-economic areas. The equipment developed for the EASI® was based on similar principles, such as the use of common, easily obtainable equipment (Mailloux et. al., 2018). The equipment used for the SASISI included wooden blocks, sand, clay, crayons and scissors that are easy to obtain and known to children in grade R and grade one in South Africa. The occupational therapy research assistants confirmed the clinical utility of the low-cost equipment in Phase two. An added observation on the clinical utility was made by as the researcher as it was found that an assessment kit fitted into a shoulder bag, which made it easier for the occupational therapy research assistants to travel between sites. This was a positive observation, as it will allow community occupational therapists to travel to various rural clinics and be able to take the SASISI assessment with them.

The cultural appropriateness of the activities also considered the verbal instructions that were needed. The content analysis in Chapter 4 found that language was one of the most important aspects to consider in the development of an instrument. In the development of the instructions for the SASIS the researcher considered the fact that in South Africa there are 11 official languages (Statistics South Africa, 2017), as well as the fact that the literature review pointed out that children from low socio-economic environments have difficulties with language development. The first three activities namely dressing and undressing, walking heel-toe and star jumps did not require many specific verbal instructions as demonstrations of what was expected worked well. The verbal instructions for the construction of blocks, clay activities and cutting with scissors were however more problematic as it required more detailed instructions.

Venter (2000) emphasised the importance of administering an assessment in the child's home language, as this would prevent the measuring of their ability to understand English, rather than their ability to perform the activity.

This practice will bias the results and will not provide information on the construct being measured. The use of translators within the community is also problematic as there are no trained translators available and the occupational therapists would need to give the verbal instructions. In an effort to solve this problem, the researcher developed a sheet with short phrases in six different languages for each activity. By doing this, the researcher aimed to improve, the reliability of the instructions and children's understanding of what to do.

The criteria set for instrument development and the activity analysis process guided the researcher in developing an administration format that was comprehensive, yet practical. This was a tedious process, but the final administration format was found to be appropriate and easy to use in the South African context. It was helpful to note that the occupational therapy researcher found the administration format unique, appropriate for the context and easy to use. The layout of the administration of the activities influenced the layout of the scoring format.

The scoring format was based on the observations of the execution of the actions within each activity. The aim of the scoring was not to measure if the child was able to execute the action or not but rather considered how the actions were executed. A simple score of yes or no or incorrect, approximately correct or correct, as used in the SIPT, were therefore not appropriate (Ayres, 2004). An ordinal 4-point Likert scale was chosen to guide the scoring of the observations. Retief et. al. (2013) proposed that using an even number scale is less problematic as it as it forces the occupational therapist to decide to either choose a score of 1 or 2 when the child is having difficulties, or a 3 or 4 when the child is finding the actions easier to do. Each option for scoring was described in terms of the amount of support the child needed to initiate, participate and accomplish a task, the accuracy of movements and task completion, coordinated movements during motor activities, and the rhythm and fluency of their movements. The activity analysis determined the sensory integration domain that was measured for each of the observable actions. The scoring sheet was therefore designed in such a way that a score was captured next to the action, but under the sensory integration domain that was measured. The scores for each sensory domain were totalled to provide information on which sensory integration domains were at risk. This scoring system worked well, and the occupational therapy research assistants found the scoring system easy to use and scoring sheets easy fill in. A negative aspect of the 4-point system used was that the occupational therapy research assistants found it difficult to discriminate between borderline scores, as well as to score the several aspects of scoring at the same time. They also reported that the behavioural domains were difficult to score and needed more detail. These issues were addressed during the Rasch analysis and following the clinical utility testing in Phase two. These aspects will be discussed in more detail under these headings.

Objective 3 was concluded by the formalisation of the administration and scoring format of the screening instrument. This screening instrument was subsequently named the South African Sensory Integration Screening instrument. The theory on instrument development, as described in Chapter 3, showed that the instrument development did not stop at the administration and scoring format, as an administration manual and training programme is needed to ensure valid and reliability use of the instrument. The importance of this step was observed during the field-testing in Phase two, that not all the occupational therapy research assistants had the same level of observational skills and could influence the rater reliability. This observation emphasised the importance of a comprehensive administration manual and training on the scoring of the observations.

7.2.3 Objective 4: Administration manual and training program

Kielhofner (2006b) proposed that the administration manual aid in the standardisation of the instrument as it lessens the variability in the way an instrument is administered and scored. Guidelines for administration, scoring and the interpretation thereof are important to ensure that occupational therapists from around South Africa use the SASISI in the same manner. Criteria such as the rationale of the instrument, the population the instrument is intended for, the developmental procedures that were followed, specifications on user qualifications, detailed instructions on administration and scoring were included in the guidelines. Training on the administration of the screening instrument and appropriate scoring is essential and Kielhofner (2006a) proposed credentialing of administrators to determine competency of administration and scoring. Fisher and Jones (2010) founded during the development of the AMPS that administrators need to become calibrated raters. The authors argued that this rating process will ensure competence in scoring but also determine if an administrator is strict or lenient in scoring (Fisher and Jones, 2010). The rater calibration process in the AMPS includes attending a training workshop and the rating of observations during the course and 10 observations after the course. The authors argued that this process ensures valid and reliable scoring (Fisher and Jones, 2010). A similar process was followed in the development of the training program for the SASISI.

The training programme is of immense importance, as the SASISI will be used by community occupational therapists who are newly qualified and with a limited knowledge of sensory integration.

The researcher believes attending the training programme prior to using the instrument should be compulsory, a decision based on the fact that due to the occupational therapists limited sensory integration knowledge, the standardised administration and correct scoring of the instrument can only be accomplished by the appropriate training. The observations made during the field-testing, on the occupational therapists' varying levels of observational skills, confirmed the decision to make a training programme compulsory. A possible obstacle to attendance of training could be taking time away from work or the need to travel to attend the training. The researcher therefore designed a training programme using a blended learning approach of online learning as well as face-to-face sessions to practice and check administration and scoring. Administrators have access to an online training programme that they can work through prior to the face-to-face workshop. The occupational therapy research assistants commented that this approach was beneficial to their learning process. The researcher believes this was a cost-effective way to present the training as occupational therapists only need to take one day away from work and less time was spent on teaching theory and more on practical application. The researcher will recommend this approach to future instrument developers as it will bring down the costs of training but increase the training opportunities for administrators of the instrument.

7.2.4 Conclusion discussion Phase One

The discussion on Phase one showed that all four objectives for this phase were met as activities were identified to measure sensory integration and consensus was reached on six of these activities. Objective 3 set out to develop the administration and scoring format using activity analysis and the observation of the child's performance during the activities. The last objective included the development of the administration and scoring manual. By the end of Phase one, a screening instrument, named the South African Sensory Integration Screening Instrument or SASISI, was a reality. To ensure the validity of the SASISI, Phase two set out to determine the internal construct validity and the clinical utility of the instrument.

7.3 DISCUSSION OF RESULTS OF PHASE TWO

Crocker and Algina (1986) proposed that once the instrument format had been established it should be field tested on a similar population. Phase two had three objectives and focused on the pilot study that was done to determine administration and scoring difficulties, an investigation into the construct validity, as well as investigating the clinical utility of the SASISI.

7.3.1 Objective 1: Pilot testing

Prior to the field-testing, a pilot test was done to determine difficulties in administration and scoring of the SASISI. Crocker and Algina (1986) found the preliminary try-out of the instrument provided valuable information prior to field testing the instrument. This was a very worthwhile task as several difficulties with administration and scoring were identified. Difficulties with instructions were identified due to the children not understanding English. This finding led to the development of a sheet with key terms to help the administrator when a child does not understand the instructions. Feedback by occupational therapy research assistants in Phase two of the study was positive, as they found the sheet with instructions very helpful. Some difficulties with the scoring format were identified and the scoring guidelines were adapted to include descriptors that are more detailed for each score.

Characteristics of the low socio-economic population involved in this study

The relationship between the child and their context or environment forms an essential part in the development of their performance. The environment the child grows up in, is however, not static and several types of environments, such as the observable environment, the social environment and the cultural environment, make a contribution (Bronfenbrenner, 2009; Dunn et. al., 1994). The literature review in Chapter 2 investigated the child's ability to process and integrate sensory information from low socio-economic environments, and further proposed that adverse environments can have a destructive influence on all aspects of child's health and well-being. The literature on risk factors for child development in low socio-economic environments included discussions on the availability of food and healthcare, safe living environments, stimulating and supportive opportunities and materials for learning and socio-emotional support (Bradley and Putnick, 2012). The findings from the demographic results on the same aspects as above are in agreement with the discussion on the literature discussed in Chapter 2, as well as the data from the Child Gauge (Delany et. al., 2016).

Inclusion criteria for the study included children aged 5 years 0 months to 6 years 11, as traditionally this is the age that children in South Africa start to attend school and when learning and behaviour difficulties are identified. This age group is traditionally enrolled in grade R or grade one, the foundation phase of the South African schooling system. Since 2010, National Department of Basic Education (2011) set admission ages for grade R, as age 4 turning 5 by June in the year of admission, and grade 1 as age 5 turning 6 by June in the year of admission; children need to be attending grade 1 by the time they turn 7 years old. The attendance of grade R was implemented as part of an early childhood development policy to provide opportunities for learning and prepare children for formal schooling, especially in low socio-economic environments (Department of Basic Education, 2001). Unfortunately, this rule of the Act was only made compulsory from 2014 and children from low socio-economic areas frequently only start to attend school at the age of 7 years (Janse van Rensburg, 2015).

The school in Soweto was the biggest with 1554 learners at the time of the pilot testing, and the largest group came from this school as 99 children qualified for inclusion in the research. Only 44 children were included from the school in Alexandra and 57 children from the school in Potchefstroom even though these schools also had more than 1000 learners. The researcher found that a sizable percentage of children in both Soweto and Alexandra were already older than 7 years and could not be included in the study. A possible explanation for this could be that children only started school in the year they turned 7 years of age, or due to high numbers of children needed to repeat grade 1. Kuépié et. al. (2015) confirmed that late registration to school and grade repetition is high in Sub Saharan Africa. In terms of age groups, 152 children in the group were older than 6 years 0 months and only 48 children were between 5 years 0 months and 5 years 11 months. A possible explanation for this could be that children had already turned 6 years by the time they were assessed in August and September of the year the pilot study was done. These findings meant it was difficult to determine reliable data on the differences in performance between the age bands for the younger children. The implication of this finding is that a larger sample of children needs to be assessed to include more children from the different age bands. Another implication is that the testing period needs to be at the beginning of the school year in January to include more of the younger children.

The research sites consisted of two schools in Gauteng townships, namely Soweto and Alexandra, as well as one school from a township in Potchefstroom in North West province. Even though all three sites are classified as poverty stricken, the townships differed in context, as Soweto and Alexandra were classified as urban areas and Potchefstroom as a rural area.

This classification is based on statistics from the Child Gauge of 2017, which found that 97% of the overall population in Gauteng lives in urban areas, with only 46% of the population in North West Province in urban areas and the rest in rural areas. Ward and Shackleton (2016) described urban areas to have a higher population density with small plot sizes and the head of the household to have a lower level of education. These phenomena were seen in the results of the background information from the HESSI questionnaire for this sample population. The high population density and smaller plot sizes prevent active exploration of the environment and could result in the disruption of sensory integration development. The literature review in Chapter 2 further described the link between lower levels of education in the mother and the provision of appropriate stimulation and opportunities to develop sensory integration. It is important for the occupational therapist to take note of these above-mentioned findings when assessing a child as it may influence the child's performance and result in sensory integration difficulties.

Soweto encompasses the biggest physical area with a population of 1 271 628, of which 19% are children, followed by Alexandra with a population of 179 624 and Potchefstroom with a population of 87 701, of which only 7% are children (Statistics South Africa, 2017). Even though Soweto had the biggest population, the population density in Alexandra was the highest with 26 000 people living per square kilometre compared to Soweto at 6 357/km² and Potchefstroom at 5 000/km² (Statistics South Africa, 2017). The high population density in Soweto and Alexandra is concerning as it could result in overcrowding and household chaos that is characterised by noisy, overcrowded houses that are unpredictable with frequent change in family members and income (Garrett-Peters et. al., 2016). Evidence from the literature review indicated that children from household chaos display behaviours similar to those with sensory reactivity. Garrett-Peters et. al. (2016) proposed that children living in household chaos have fewer opportunities to develop their regulatory systems and may find it difficult to adapt to the environment resulting in blocking out the environment or withdrawing from all the stimulation. The link between household chaos and sensory reactivity has not yet been investigated, but the above discussion has important implications for occupational therapy practice and assessment of sensory integration difficulties. The OTPFIII emphasises the importance of investigating the child's context when compiling an occupational profile and the above-mentioned findings highlighted the importance of doing a thorough assessment, so that these factors are not missed. A second implication of these findings is that occupational therapists working in low socio-economic environments need to suspect sensory integration difficulties and need to include an assessment for sensory reactivity in their assessment.

Results from the HESSI questionnaire further showed that children in Soweto and Alexandra live in small one to two-bedroom dwellings, with an average of 5.7 people inhabiting the space. In Potchefstroom the dwellings had an average of two to three rooms but a higher number of people (6.1) living in the dwelling; these results are much higher than the average household size of 3.4 people, as reported in the 2014 household survey (Hall and Budlender, 2016). The type of dwelling the child lives in also plays a role in overcrowding, as 9% of the South African population live in informal dwellings, with the highest percentage in the two provinces that were studied, e.g. North West province (17%) and 13% in Gauteng (Hall, 2017). Types of housing varied considerably between the three research sites, but in Soweto and Potchefstroom, most participants lived in informal housing. Informal housing consist of shelters or dwellings built from cheap materials such as corrugated iron sheets, wood or plastic (Hunter and Posel, 2012). Formal housing such as owning your own home probably alludes to the Reconstruction and Development Programme (RDP) where the government provides low cost housing to families (Shackleton et. al., 2014). The types of dwellings the sample population lived in differed between the three research areas, with more than half of the population in Soweto and Potchefstroom living in informal housing or shacks and 25% living in their own home (formal housing). In Alexandra, 32.3% lived in their own formal home with 32.2% living in a room or garage they shared with other families and two participants were found to be homeless. Not only did Hall (2017) find overcrowding detrimental to a child's health or development, but also informal housing. Children living in informal housing are frequently exposed to hazards such as poor sanitation, limited space to play and limited access to water or electricity. Bradley and Putnick (2012) emphasised the importance of quality housing with a separate area for cooking with a stove or fridge, access to clean water and proper sanitation for water and toilets for the prevention of malnutrition. The HESSI questionnaire did not provide information on the availability of space to play, access to water and electricity. The questionnaire did indicate that less than 50% of families in Gauteng and North West Province had separate bathrooms, and most of the population had outside toilets. In North West Province, 76% of families had a separate kitchen for meal preparation but less than 50% of dwellings in Soweto and Alexandra had separate kitchens and meals are prepared in the room in which the family is living. The limited availability of these facilities contributes to poor sanitation, health hazards and possibly poor nutrition. Exposure to poor nutrition and unhealthy living spaces have a negative impact on children's development and may result in sensory integration difficulties. McCoy et. al. (2015b) confirmed that malnutrition results in inadequate energy resources needed for exploring the environment and cognitive development. Again, it is important for occupational therapists to be aware of these environmental influences as the child's poor participation could be due to a lack of energy because of poor nutrition or illness rather than difficulties with sensory integration.

The small size of the houses, as well as the limited availability of space to play could play a role in the child's motor skills development, as they do not have the opportunity to participate in motor activities that require large movements. Unsafe neighbourhoods are also frequently seen in low socio-economic environments. Duncan et. al. (2017) found there is an increase in the rate of crime and violence in poverty-stricken neighbourhoods, which could influence the child's safety when playing outside. Surprisingly, more than half of the caregivers in all three townships felt the neighbourhood was safe, which could possibly be due to the availability of other family or friends living in the same dwelling or close by. Schoeppe et. al. (2015) argued that the social cohesion and solidarity among residents could influence parents' perception of the safety of the neighbourhood. Even though caregivers felt the neighbourhood was safe, 62.5% of caregivers in Soweto and 50% in Alexandra were still concerned about their child's safety outside the house. This number was much lower in Potchefstroom and could possibly be due to the smaller rural environment they live in, with larger plots that are fenced where the children can play. The implication of the above-mentioned findings can be twofold. Firstly, occupational therapists working in these environments need to be aware of the possible trauma these children face on a regular basis and the resultant emotional and behavioural difficulties. Careful observations of the children's emotions and behaviours are needed to distinguish between mental health difficulties or sensory integration difficulties. Raver et. al. (2015) found that prolonged environmental threats affected their physiological ability to modulate their mood states and they live in a constant state of high arousal that influences their level of reactivity. The ability of children to modulate their mood states are related to behaviours observed in sensory integration when a child is having difficulty with sensory reactivity. Secondly, because the occupational therapist uses a family-centred approach with children, they need to consider the mother's emotional reactions and the impact on their parenting style. McCoy et. al. (2015a) linked the mother's level of education to harsh parenting, which undermines the child's ability to develop adaptive behaviour and relevant emotional skills.

South Africa has a large population of children that live without parents or with only one parent compared to the rest of the world. Due to adult labour migration, it is found that families are fragmented with fathers not having ongoing relationships with a child's mother and not contributing to the household or the care of the child (Hall and Budlender, 2016). The burden of care therefore frequently falls to the mother or other members of the family, such as grandparents. Household statistics showed that in quintile one areas (most poor) 40% of children live with their mothers and only 3% live solely with their fathers (Hall and Sambu, 2017). The results of the HESSI indicated higher percentages, as 59.4% of children in the Soweto sample lived with their mother, 55.9% in Alexandra and 47.6% in Potchefstroom.

Meyer (2016) found matching results in the Northern Free State, with more than 50% of female-headed households. This study also found that female-headed households were worse off, especially in terms of income levels and parenting. This is concerning, as consistently with national statistics the mother was found to be the main income provider in Soweto (48.65), Alexandra (55.9%) and Potchefstroom (50%). Ford and Stein (2015) found that due to poor finances there are little resources available, such as books, educational toys and toys, to encourage exploration or create a stimulating environment. This type of environment will negatively influence the child's ability to actively engage with their environment and form adaptive responses (Ayres, 2005). These finding are distressing as it means that 62% of children in South Africa start their lives at a disadvantage. Early childhood programmes are aiming to address the lack of stimulation in children from low socio-economic environments, but from personal experience children access these services too late. This poses an opportunity for occupational therapists working in low socio-economic environments to implement stimulation programmes at a clinic level. A possible intervention could have occupational therapists conducting short parent training programmes for mothers when they bring their baby to the clinic for health check-ups and immunisations. This proposal will fit in with the National Department of Health (2017) re-engineering of primary healthcare and the implementation of the ideal clinic.

Mothers are frequently single parents and this was seen in the results as large percentages of mothers in the sample population were never married or were living with a partner, with only 12.5% in Soweto married and living with a partner, 8.5% in Alexandra and 21.4% in Potchefstroom. Hall and Budlender (2016) reported that recently there was a decrease in marriage rates, with only 32% of woman married and 11% living with a partner. Living with a single parent can be unfavourable for a child's development as Duncan et. al. (2017) found that single parents have less time and money to invest in a child's stimulation, provision of formal learning resources or nurturing relationships, due to long working hours and limited finances. Single parents were also found to experience chronic stress that could influence their parenting practices as well as the children's stress levels (Chaudry and Wimer, 2016; Duncan et. al., 2017). Stress has a negative impact on the child's ability to react successfully to the environment and to create successful adaptive responses (Schaaf and Mailloux, 2015). Raver et. al. (2015) found that elevated stress levels to environmental threats affected their physiological ability to modulate their mood states. These children lived in a constant state of high arousal that influenced their level of sensory reactivity, resulting in emotional and behavioural difficulties.

The mother's level of education was found to play a significant role in all areas of child development (Blair and Raver, 2016; Grantham-McGregor, 2007; Naudé et. al., 2003; McCoy et. al., 2015b; Ursache and Noble, 2016). Surprisingly mothers from this sample population were mostly educated up to a secondary level or higher in Soweto with equivalent results in Alexandra. In Potchefstroom, 11.9% of the mothers had less than grade 5 (primary school). Not only does the mothers' level of education influence the child's development, it also limits job opportunities, as higher paying jobs often require a higher education.

Less than 21.5% of families living in Soweto, Alexandra and Potchefstroom owned their own car, which means the family, as well as the children, need to walk or make use of public transport to access education and healthcare. The Household Survey of 2016 showed that 66.3% of children across South Africa walk to school, whilst 44% of families in Gauteng and 36% in Potchefstroom make use of taxis to travel (Statistics South Africa, 2017). Nkonki et. al. (2011) found that although basic education and healthcare are free for families living in low socio-economic environments, transport costs are high and access to these services are not free and this adds an additional cost to the already small income of a family. Walking to school further takes time that children could spend on learning, playing and activity exploring the environment for sensory integration.

It was important to determine the languages spoken by the sample population as it could influence the administration of the instructions and the resultant participation within the screening instrument. In South Africa, the language of learning in schools is English, which in many cases may be a child's second or even third language. In the foundation phase, children are taught in their home language, yet due to the variety of languages spoken in each area not all languages can be incorporated into the classroom (Margetts and Phatudi, 2013). In Soweto a variety of languages are spoken but the most frequently spoken are isiZulu and Sesotho and similar trends are seen in Alexandra, with isiZulu and Sepedi as the most frequently spoken languages (Statistics South Africa, 2017). This trend could be due to the high influx of migrant workers from KwaZulu Natal, the homeland of the Zulu people. In the sample population isiZulu was spoken the most in Soweto, but Setswana was spoken the most by the sample population in Alexandra, followed by isiZulu. Most children in Potchefstroom spoke Setswana, which is in line with national statistics. The overall sample population spoke mostly Setswana, followed by isiZulu, followed by Sesotho and isiXhosa. The results of the different languages spoken were important as it guided the languages used for administration of the screening instrument as well as the translation of the SIPT instructions for use in Phase three of the study. The implication is that children speaking a variety of languages access occupational therapy services in low socio-economic environments.

By providing instructions for the SASISI in different languages, the occupational therapists will be able to use the SASISI for a larger population.   This will make the implementation of the SASISI in clinics in these areas accessible and acceptable to the population

The above findings confirm that the population included in the study were from a low socio-economic environment, with similar levels of poverty as published in the Child Gauge 2016 (Delany et. al., 2016). The discussion highlighted the influence of population density, housing, household chaos, the mother's level of education, unsafe neighbourhoods, unavailability of stimulating environments and language on the child's sensory integration development.

7.3.2 Objective 2: Internal construct validity testing

To ensure the screening instruments measured the underlying sensory integration construct it was necessary to determine if the instrument displayed acceptable internal construct validity. Cook and Beckman (2006) suggest that the construct validity of an instrument needs to be determined first to ensure that the instrument is measuring the construct for which it was designed. The internal construct validity of the SASISI was determined using the Rasch model, rather than the traditional factor analysis. The Rasch requirements were found helpful to identify exact problems in item functioning and scoring accuracy. To fit the Rasch measurement model, the instrument did not only needed to achieve uni-dimensionality, but also needed to address category or threshold ordering, person and item fit measures, testing for local independence, the Person Separation Index (PSI), differential item functioning and bias in independent variables within the sample, such as gender or age and uni-dimensionality (Bond and Fox, 2015; De Klerk et. al., 2013; Retief et. al., 2013).

Although an intricate and lengthy process of analysis, the Rasch results assisted the researcher to pinpoint problems in item functioning and threshold ordering. The Summary Statistics Table in Chapter 6, Table 6.21, shows the different solutions done to improve overall fit of the domains of the SASISI. Important to note is that the nine domains were seen as individual tests of the SASISI and that the intention was not to sum the scores for each domain or test but rather have individual scores per test to indicate areas of ability and dysfunction. However, items in each domain were intended to be summed to get a total score, which should indicate the level of ability in the child for that sensory integration component.

The domains with the best results were Object handling and Bilateral integration and sequencing with an overall Chi-square fit of 0.49 and 0.08 respectively. The implication for practice is that these two domains have good internal construct validity, they measure what the construct sets out to measure and thresholds for the scoring is ordered and can discriminate between persons with low and high ability to endorse the item. There is no local dependency between the items (one item giving cues to perform well in another item) and no discrimination between genders (certain items easier or harder for girls or boys). Uni-dimensionality, which indicates that the Likert type of scores may be converted to interval scales and thus be summed to get a legitimate total score, was achieved for object handling but not for bilateral integration and sequencing.

What was interesting to find with the other tests or domains was that Sensory reactivity, Organisation of space and environment, as well as Organisation of self and behaviour achieved uni-dimensionality but could not fit most of the other Rasch requirements. Usually uni-dimensionality is the last requirement to test and when the preceding requirements are not met, uni-dimensionality is unlikely to happen. What is different for these three domains, is that none of them underwent sub-testing (combining items with residual correlations >0.3 into a group). These three subdomains were based on the observations of the child's behaviour. Threshold ordering for these three domains showed that the Likert scale of 1 to 4 did not work well as a scoring method. Using feedback from the Rasch analysis, as well as from the research assistants, the researcher changed the scoring for the sensory reactivity, organisation of space and environment and the organisation of self and behaviour to yes/no answers. The research assistants expressed their difficulties in identifying the differences between borderline scores for these three behavioural domains and agreed that a scoring system of yes/no would be more useful when observing the child. This could be a possible explanation for the findings above.

The ordering of thresholds of response categories is one of the first steps in determining if the data fit the model. The threshold ordering showed overall the scoring of the SASISI using a Likert scale of 1 to 4 worked to assess the child's ability to endorse easy to difficult items. Several categories or thresholds of specific items were collapsed and where it did not improve overall fit to the RUMM, the items were removed. Only one domain, namely Bilateral integration and sequencing, were retained despite poor fit; this was based on clinical observations and will be investigated in future studies.

The Rasch model requires item to be ordered according to the Guttman structure, where the items are ordered on a continuum from less difficult to more difficult (Curtin et. al., 2016). This was seen as one of the limitations of the screening instrument, as items were not necessarily ordered according to difficulty, but focussed on observations of the execution of the part of the activity.

This limitation probably attributed to the poor fit of the screening instrument to the Rasch model. Further investigation is needed to determine if the current format of observations of actions as items is the most appropriate format for use in this instrument.

Bond and Fox (2015) proposed that item fit statistics could be measured as a mean item fit residual score, where the score needs to be closer to 0 and the SD closer to 1. Individual item scores indicate where logits must fall within a range from ± 2.5 for fit within the model. None of the subdomains had mean item fit residual scores close to 0, with the closest score of -0.05 for Object handling. All the domains, except for the Praxis, Visual form and space and Sensory reactivity domains had individual item fit between ± 2.5. This indicates that although the individual items score still fit in the expected range between ± 2.5, the individual items were not well targeted, i.e. not to hard or not too difficult. Further research and development of the SASISI on larger samples is therefore needed.

The Chi-square value, where a value of > 0.05 indicates an overall fit of the data to the Rasch model. The assumption is that there should not be a significant difference between the expected values (expectations of the model) and the achieved values (results of the instrument). The results of the Rasch analysis found that only the Bilateral integration and sequencing and the Object handling domains fit the Rasch model criteria for Chi-square scores of >0.05. This indicates these domains discriminated well between the underlying constructs as discussed at the beginning of the discussion.

Sub-testing improved fit to the model in five of the domains namely Sensory perception, Bilateral integration and sequencing, Praxis, Handling of objects and Visual form and space. During the sub-testing, a considerable number of items were removed. Tennant and Conaghan (2007) warn against removing items as they were included for a reason, but the initial items selected came from a process of using the observable actions as items. This resulted in duplication of items or items that were not adequately described. The researcher decided to rather have too many items, as statistical analysis and clinical judgement would help to eliminate some, as to having too few as statistical analysis could never tell which items were missing. Clinical judgement might have helped but the overall approach to the items was to include all theoretically relevant items and eliminate as the process of analyses proceeds.

In eight of the nine domains, no local dependency was found. This indicates the items contributed individually towards the screening of the ability of the person to successfully complete the task and not influence other items. Only Organisation of self and behaviour did not achieve local independency.

This domain was based on observations of the child organising themselves and the resultant behaviours during assessment. As discussed earlier the scoring of this domain was problematic and the occupational therapy research assistants found it difficult to discriminate between borderline observations and scoring. The scoring was subsequently changed to address the interdependency of items.

Differential item functioning was only found in the Visual form and space domain between the female and male scores for three subtests. This was a good result as the implications are that few of the items discriminate between boys and girls. The specific activities involved in this slight discrimination could be the construction of block activity, the clay activity and the cutting activity. In future, these activities could be split to have a gender specific activity for boys and girls.

The Person Separation index (PSI) was not achieved at all, although three of the domains namely Praxis, Visual Spatial and Organisation of self and behaviour were above 0.8 but not the required 0.85. Implication of this is that there are items that are not yet sufficient to separate persons with high and low ability. This index is however dependent on the sample and if the sample contains persons with higher ability, the PSI cannot be generalised to a normally distributed sample. In effect, the PSI values lower than 0.85 showed there was not a normally distributed sample rather than poor item functioning. Since the Rasch analysis was done to identify problems and not to claim construct validity, the researcher took note of these values and in future research more attention will be given to normally distributed samples.

Uni-dimensionality was reached for the Object handling, Sensory reactivity, Organisation of space and environment and the Organisation of self and behaviour domains with scores below the required 5%. This shows these domains adhered to the requirements of the Rasch model and were measuring that for which they were designed. The uni-dimensionality for the three behavioural domains were discussed at the beginning of the section.

Although it is disappointing that the other domains did not reach uni-dimensionality, it was not completely unexpected, as sensory integration is a complex process that involves taking in and processing information from the environment through different senses and thus difficult to conceptualise as only one construct (Ayres, 1972a). Sensory perception is defined as the ability to interpret the temporo-spatial qualities of sensory input from all the sensory systems and this domain measures information from all sensory systems (Smith Roley et. al., 2001a; Schaaf and Mailloux, 2015). The sensory perception domain is therefore not uni-dimensional in nature. The postural ocular domain is similarly multi-dimensional as it involves processing information from the vestibular, proprioceptive and visual systems (Ayres, 1972a).

These systems contribute to the underlying aspects of the postural ocular domain, namely eye movement/ocular motor control, postural tone and control, body scheme, proximal stability, balance reactions, righting and equilibrium reactions and postural adjustment or background movement, as discussed in Appendix A (Ayres, 1972a). The bilateral integration and sequencing domain similarly include the combination of the vestibular, proprioceptive and visual systems to be able to generate, for example, coordinated and rhythmic sequences of movements and midline crossing (Ayres, 1972a).

The praxis domain was also found not to adhere to the uni-dimensional criteria of the Rasch model. The items within this domain include the three processes of ideation, motor planning and motor execution (Anzalone and Lane, 2012). These processes are based on the ability to discriminate information from the tactile and proprioceptive system and are not focused on one specific aspect of sensory integration or praxis. These items are based on the observations of practice behaviour rather than specifically testing an aspect of praxis. Lai et. al. (1996) analysed the SIPT tests that identify praxis components of a child's performance using the Rasch model. Five tests, namely BMC, SPr, OPr, GRA and PPr, were analysed to determine the uni-dimensionality of the tests to measure praxis. The results further indicated that all five tests were uni-dimensional and measured the same thing.

Although these four domains did not achieve uni-dimensionality, or a score of < 5%, binomial testing showed that uni-dimensional scores still fell within the confidence interval of ± 2.5 for all domains. This meant the total raw scores for these domains could be summed.

The difficulties in fit to the Rasch model was a disappointing finding, as it indicates that the internal construct validity is not as good as expected. Harvey (2016) did however warn that the stringent criteria of the Rasch model does not consider real-world situations in measuring. Whittaker and Worthington (2016) stated that the Rasch model does not consider the variability of the underlying construct or consider the variability in the relationship between items and their traits. The researcher reasoned that the multi-dimensionality of sensory integration, as well as the observational format of the screening instrument, were not clearly considered. A possible limitation in the use of the current observational format was that items were not getting progressively more difficult but were based on the performance of the steps of the activity.

One realisation not to discard is the fact that the SASISI was developed as a screening instrument and not a comprehensive assessment of sensory integration components. The researcher would like to test out the instrument on more samples, which are normally distributed before changing more aspects of the instrument.

Positive aspects of the Rasch testing were the opportunity to compare items difficulty to person ability refine items and the clarity of the observations and scoring. Following the Rasch analysis, the qualitative process of determining the clinical utility of the SASISI contributed to further refinement of the instrument.

7.3.3 Objective 3: Determining the clinical utility of the SASISI

Glover and Albers (2007) believe a screening instrument should not only be psychometrically sound but also practical and usable in the context for which it was designed. The Rasch analysis provided valuable information on the usability of the SASISI for assessment of sensory integration difficulties. This analysis was followed by a qualitative investigation of the clinical utility or usability of the SASISI.

The positive feedback from the occupational therapy research assistants included the ease of administration, the use of a unique format, cost effective equipment and the enjoyment by the children. These findings fit with the consideration of usability discussed by Glover and Albers (2007). The first consideration includes ensuring that the instrument is cost effective. Equipment used in the SASISI was found to be easily obtainable and low cost, which means the hospital or occupational therapist have minimum expenditure in obtaining the equipment. It was also found that the equipment could easily be put in a shoulder pack and taken to various clinics. A second consideration includes the suitability of the instrument for the target population and setting. The occupational therapy research assistants indicated that the activities are easy to administer either through demonstration or by using the list of key terms for instructions. They further commented on the fact that children enjoy the activities and are very excited about taking the end-product home. These factors make it easy to administer the SASISI in clinics or in public healthcare settings as the activities are universal to various ages, gender and cultures. Thirdly, the administration of the instrument should not put unreasonable burden on the occupational therapy resources. As the SASISI is easy and short to administer the occupational therapist will be able to complete the assessment in less than an hour. This means the child does not to return to the occupational therapy department to complete the assessment. The sensitivity of the SASISI was found to be high (see 7.4.3) and therefore able to identify children with sensory integration difficulties correctly preventing over diagnoses and servicing.

A negative finding however was the occupational therapy research assistants had difficulty with the scoring format. The Rasch analysis did indicate that the items were not well targeted. The feedback from the occupational therapy research assistants did clarify some of the scoring issues.

The findings showed that they had difficulty in discriminating between borderline scores and the scoring of behavioural observations and that there was a need for more detailed descriptions of the observations. Although these were negative findings, it assisted the researcher in the refinement of the instrument. The scoring format for behavioural observations was changed to yes/no and descriptions that are more detailed were given of observations to improve the ability to discriminate between borderline scores.

7.3.3 Conclusion discussion Phase Two

The objectives for Phase two were researched as the internal construct validity was established through the Rasch analysis. Although the results were disappointing to the researcher, several aspects of construct validity were achieved across specific domains. However, the SASISI is now ready to be implemented and continued research into the validity aspects will follow. A positive aspect was that the clinical utility investigation indicated that the SASISI is an appropriate tool for community service occupational therapist to use in low-socio-economic environments.

7.4 DISCUSSION OF RESULTS OF PHASE THREE

The objectives for Phase three aimed to determine the psychometric properties of the SASISI. The content validity, concurrent validity as well as sensitivity and specificity were investigated.

7.4.1 Objective 1: Determining Content validity

The content validity is important as it comes from a clinical expert opinion more than from a statistical analysis point of view. Having the Rach analysis as the approach to identify item functioning and overall internal construct validity, the content validity now adds another dimension.

Lynn (1986) proposed that a minimum of five experts are needed to reach appropriate agreement for content validity, and the sample of experts in this study included six occupational therapists with expert knowledge on sensory integration. The fact that the experts were all practicing for a minimum of nine years and with more than six years' experience, as well as their involvement in sensory integration training, gave the researcher confidence in their judgement.

A positive finding of the content validity testing was that the experts agreed on the items of the SASISI as content validity of the items ranged between 0.96 and 1.00, well above the proposed 0.83 (DeVellis, 2016). The experts could not reach consensus on only three items and these items were subsequently removed. Content validity is dependent on expert judgement of the items rather than statistical assessment. The statistical analysis of items in the Rasch model found that items were not well targeted, yet the experts in sensory integration judged the items appropriate. Despite these conflicting findings, the researcher believes the items were relevant, as confirmed by the content validity, but need to be described in more detail in order to discriminate between easy or difficult as pointed out in the Rasch analysis. Further research with larger samples is therefore needed.

7.4.2 Objective 2: Determining Concurrent validity

Concurrent validity is determined by concurrently testing the same sample on two tests that measure similar constructs, in this case the SASISI vs. the SIPT. A sample size of n =36 was proposed, but only a sample of n = 28 could be assessed. This smaller sample was due to variable such as the availability of children and SIPT testers during the available assessment period. A possible explanation for the smaller sample size was that the SIPT could only be assessed by occupational therapists who completed the SIPT training. Only five occupational therapists, including the researcher, were able to do the assessments within the available timeframe. Unfortunately, external factors such as taking out time out of work hours, the length of the SIPT, the time children were available for assessment and travel to schools and clinics influenced the number of children that could be assessed. The final sample consisted of mostly children over 6 years of age and with an overwhelming percentage of children from Ikageng in North West Province. These factors make it difficult to generalise to the larger population of children living in low socio-economic environments.

Significant moderate correlations were found between various domains of the SASISI and SIPT subtests. The discussion will focus mainly on significant correlations, i.e. <0.05 as the significance emphasises the realness of the finding (Kielhofner, 2006b).
A moderate significant correlation was found between the **Sensory Perception Domain** of the SASISI and the SV test of the SIPT. The SV test measures the mental ability to change the position of an object in space within a specific time frame (Ayres, 2004). This sensory perception domain aims to measure the child’s ability to discriminate and interpret sensory input from the tactile, proprioceptive, vestibular and visual systems.

A possible explanation for the relationship between SV and sensory perception could be the fact that both tests involve the discrimination and interpretation of visual input.
As the literature indicated children from low socio-economic have more difficulties with visual input, the above finding is a positive result as it means the SASISI will be able to identify children with visual discrimination difficulties in low socio-economic areas.

The **postural ocular domain** showed a moderate significant correlation with the SV test of the SIPT. A possible explanation for the relationship between postural ocular control and space visualisation could be the fact that visual spatial skills play a role in detecting the body's position in space and maintaining posture (Dahl Reeves and Cermak, 2002). This is a motor free test but does provide information on visuopraxis (Ayres, 2004). Possible visuopraxis difficulties could be due to ocular motor control that influences visual tracking or the coordination between the movement of the eyes, head and neck during the SV test (Bundy et. al., 2002). The implication of this finding is that the postural ocular domain may be able to provide information on the child's body position in space and possibly the ability to control ocular motor movements.
The postural ocular domain further showed a significant moderate negative correlation with PrVC from the SIPT. A negative correlation indicates that if one test score increases, the other test score decreases; this means that if the PrVC test score declines the postural ocular domain score will increase. The reason for these finding needs to be further investigated as the two tests different various aspects of postural ocular control. The PrVC requires the child to correctly assume a posture the test assess the child's ability to follow verbal directions and plan their movements (Bodison and Mailloux, 2006). The understanding of language is there for critical for this test. The postural ocular domain however focuses more on the child's ability to assume or maintain positions during static and dynamic movements (Kramer and Hinojosa, 2010). The researcher believes that the postural ocular domain will provide valuable information on the static and dynamic movement of children from low socio-economic environments as the language aspect of movement that they struggle with will be eliminated.

The **bilateral integration and sequencing domain** showed a significant moderate correlation with the SV test. The SV test provides information on the integration of function of the two parts of the body, which may explain the relationship with the Bilateral integration and sequencing domain (Ayres, 2004).
Bodison and Mailloux (2006) explained that a poor SV score might reflect Bilateral integration and sequencing difficulties, such as poor lateralisation in activities that require skilled use of the hands or crossing the midline.

The Bilateral integration and sequencing domain also showed moderate correlations with the SPr, BMC and PRN tests from the SIPT, although these correlations were not significant. The researcher expected the correlations to be higher as all three of these test measure aspects of Bilateral integration and sequencing. The SPr test measures the child's ability to use both sides of the body in a coordinated way and the imitation of a sequence of movements, similarly to the Bilateral integration and sequencing domain (Bodison and Mailloux, 2006). Likewise, the BMC looks at the child's ability to use both sides of the body in a smooth and coordinated manner. The PRN test provides information on the processing of vestibular input and is associated with difficulties in Bilateral integration and sequencing activities. This finding does however provide preliminary evidence that the Bilateral integration and sequencing domain is measuring the correct aspects and will provide valuable information on the low socio-economic sample.

The **Praxis domain** of the SASISI showed a significant moderate correlation with the SV test of the SIPT. Although the SV test measures visual perception, Ayres (2004) proposed that the SV test also requires ideation as the child needs to form an idea of what the object would look like if turned in different orientations. This relationship between the visual perception and ideation needs to be considered when children from low socio-economic environments are assessed. It is known from the literature that children from low socio-economic environments have difficulty with visual spatial skills, but the possibility of difficulties due to ideation rather than visual skills needs to be considered. The Praxis domain further showed weak correlations with LTS and PRN. The LTS test measures the ability to discriminate tactile input on the hands and arms. Mailloux et. al. (2011) found associations between tactile tests and praxis, which could possibly explain this finding. The association between PRN and the Praxis domain raises some questions, as a low PRN is more associated with Bilateral integration and sequencing (Mailloux et. al., 2011). More research is needed on a larger sample to investigate this finding.

The **Visual form and space domain** showed two moderate and five weak correlations with SIPT tests. Only the two moderate correlations showed significance with SV and OPr. Difficulties with Visual form and space perception were expected in this population as the literature review discussed the findings of poor spatial perception skills in children from low socio-economic environments. A possible correlation was expected between the Space visualisation test and Visual form and space domains as they measure similar visual form and space perception (Ayres, 2004).

A significant moderate correlation was found between the Visual form and space domain and OPr.

This was unexpected, because the Visual form and space domain measures visual form and space perception, whereas the OPr measures the child's ability to plan tongue and mouth movements based on tactile and proprioceptive perception (Bodison and Mailloux, 2006). A possible explanation for the relationship between the two test items could possibly be due to the link with motor planning. Significant correlations between the oral praxis test and the Kaufman scales alluded to an association with motor planning components (Ayres, 2004). Another possible explanation could be the link between visual spatial skills and body position in space and the child's awareness of where parts of their body are. Similar links with motor planning and visual perceptual difficulties were discussed by Dahl Reeves and Cermak (2002). The Visual form and space domain is an important domain for measurement in children from low socio-economic environments as the literature describes their difficulties with visual and spatial perception.

The **Sensory reactivity domain** showed a significant moderate correlation with PrVC. The PrVC measures the child's ability to follow verbal instructions and use these instructions to plan and execute specific movements. Language was found to be severely affected in children from low socio-economic environments and low scores on Praxis on verbal commend were expected (Hurt and Betancourt, 2015). Descriptive statistics for this sample found that 96% of the sample had difficulties with Praxis on verbal command with a mean score of -2.82SD. Bodison and Mailloux (2006) found that children who had difficulties in the understanding of verbal instruction appeared to be inattentive and disorganised; similar behaviours are frequently seen in children with sensory reactivity difficulties (Ayres, 2005). A significant moderate negative correlation was found between the sensory reactive domain and the PRN. This means that if the PRN scores decreases the Sensory reactivity score increases. A low PRN indicates that the child is having difficulty in processing vestibular input and may result in difficulties maintaining levels of arousal and attention (Bodison and Mailloux, 2006). An increase in a Sensory reactivity scores indicates greater difficulties compared to the other domains. Following the Rasch analysis, the scoring format was changed to yes/no responses and the more yes scores indicate more difficulties with sensory reactivity. Interestingly, Ayres and Mailloux (1981) reported on the link between difficulties in the processing of vestibular input and language difficulties. Both types of difficulties result in sensory reactivity type behaviours and the author suspects that a combination of both types of difficulties increase the risk of sensory reactive behaviours.

A possible explanation for the significant weak negative correlation between the **Organisation of space and the environment domain** and the LTS could be due to engage and deal with themselves (Ayres, 2005). A negative correlation means that as the LTS score decrease the Organisation of space and the environment increase.

The implication of this is that a low LTS score may show difficulty with touch perception, resulting in an increased ability of the child to organise themselves within the environment.
A high score for LTS may however provide information on tactile defensiveness as this is a test that measures light touch at the end of a series of tactile tests (Bodison and Mailloux, 2006); similar behaviours are observed for either a low or high LTS score. These behaviours may include being restless and fidgety, impulsive in the approach to a task and difficulties in starting and completing tasks. Possible tactile defensive behaviours may be observed in the SASISI as it is organised in such a way that similarly to the SIPT, the tactile input builds up towards the end of the instrument. The occupational therapist administering the SASISI needs to be aware of this and be vigilant for difficulties with behaviour or disorganisation of the child towards the end of the instrument.

The **Organisation of self and behaviour domain** showed a significant moderate correlation with PrVC. The Organisation of self and behaviour measures observations of concentration and focus, following of instructions and motivation to participate. A similar explanation as the PrVC's relationship with the sensory reactivity domain could explain the link between PrVC and the Organisation of self and behaviour domain.

Although the correlations were not high, the moderate correlations were positive in that it shows there are some relationships between the tests. The small sample size may have played a role in the results, as Kielhofner (2006b) stated that a small sample size influences the significance of the findings. Cermak and Murray (1991) further reiterated that moderate high correlations with an instrument that measure a similar construct is not necessarily a poor result as it indicates that the new instrument is not duplicating the existing instrument.

A possible explanation for the moderate correlations could be the fact that the two instruments use different scoring formats. The SIPT is based on the scoring of items that becomes increasingly more difficult, but the SASISI's observational scoring format focuses on the performance of the steps of the activity. The internal construct validity findings showed that the scoring format for the SAISI did not get progressively more difficult and the multi-dimensionality of sensory integration were not clearly considered. However, the content validity was high and indicated that the underlying sensory integration observations were judged as appropriate for the measurement of sensory integration.

A positive observation is that the significant correlations that were found could be explained using sensory integration theory and provide preliminary evidence that the SASISI is measuring sensory integration. More research on large samples is however necessary to determine if these findings are appropriate.

7.4.3 Objective 3: Determining Sensitivity and specificity

Objective three aimed to establish sensitivity and specificity of the SASISI. The SASISI was developed to determine if children are at risk of having sensory integration difficulties. It is therefore important to have high sensitivity as the screening instrument needs to be able to detect the sensory integration difficulties being screened for, rather than a specificity that shows the proportion of children that do not have sensory integration difficulties (Campo et. al., 2010).

Comparison of sensitivity and specificity scores between the SASISI and the SIPT, SP and SPM were not applicable as these tests are diagnostic tests compared to the SASISI as a screening tool. The sensitivity of the SASISI was high at a cut-off point of >0.50, the only exception was found in object handling with a sensitivity of 98% at the cut-off point of -0.71 SD. This is however sample dependent and may change as the screening instrument is refined on bigger samples. The American Educational Research Association et. al. (2014) proposed that a sensitivity between 70 and 80% is acceptable for an accurate screening tool. Considering this guideline, the sensitivity for the SASISI is good and the instrument will assist in identifying problems in children experiencing sensory integration difficulties. Similarly, the specificity of the SASISI was equally high, indicating the instrument can identify children without sensory integration difficulties. High positive predictive scores were also found and confirm that if a child is identified as having sensory integration difficulties, the difficulties are truly due to poor processing of sensory information. These are positive findings, as Glover and Albers (2007) explained that children who are under identified may miss out on services. This is especially important in the low socio-economic context where access to occupational therapy services are problematic to start with.

7.4.4 Conclusion discussion Phase Three

Additional psychometric properties for the SASISI, as determined in Phase three, yielded positive results for the content validity, the concurrent validity and sensitivity and specificity. The content validity was high and provided evidence that experts in sensory integration agreed on the ability of the items to measure sensory integration.

Moderate significant correlations were found between items from the SIPT and the SASISI. Although these correlations were not high, it did indicate relationships between the items as expected. Sensory integration theory was used to provide explanations for possible relationships. Sensitivity and specificity were found to be high showing that the SASISI will be able to discriminate between children with and without sensory integration difficulties.

7.5 FINAL CONCLUSION

The study set out to determine if a contextually appropriate screening instrument would provide a tool that could guide community occupational therapists in the identification of children from low socio-economic communities who are at risk of having sensory integration difficulties.

All four objectives in Phase one were met as the Delphi process used for Objectives 1 and 2 yielded agreement on six activities. These activities were described in detail and were found to be similar to activities used in other paediatric assessments and the researcher felt confident that these activities could provide information on sensory integration.

Objective 3 was successfully completed following the activity analysis of the six activities. The discussion pointed out that a positive implication of the activity analysis was that the administration and scoring format was designed in such a way that it adhered to criteria set for instrument development in Chapter 4.

Finally, Objective 4 resulted in a detailed administration manual and training programme. The importance of a detailed manual was discussed. The researcher commented on the importance of a training programme to ensure standardised administration procedures as well as the positive use of a blended learning approach to training. By the end of Phase one, a screening instrument named the South African Sensory Integration Screening Instrument or SASISI was a reality.

All three the objectives were reached within this phase. A successful pilot study identified difficulties with the administration and scoring format. The results of this objective were positive, as the SASISI was refined even further before field-testing. An important outcome was the development of a sheet with key instructions for the activities in six of the official South African languages.

The characteristics of the low socio-economic sample was discussed, and the finding showed that environmental factors such as housing, population density, household chaos, poor nutrition and unsafe neighbourhoods were like those in the literature.

The importance of having knowledge of these above-mentioned characteristics were stressed.

Objective 2 of Phase two involved the testing for internal construct validity. The Rasch analysis showed that construct validity was not achieved in all domains, but there were several positive aspects across the domains. Despite the disappointing results for internal construct validity, the SASISI was found to have good clinical utility. This is a positive finding as it shows that the SASISI is appropriate for the population and context.

Phase three investigated the psychometric properties of the SASISI and yielded positive results for the content validity, the concurrent validity and sensitivity and specificity. Objective 1 was achieved as the content validity was found to be high; this was a positive finding considering the disappointing results for internal construct validity. Construct validity is not a statistical test but report on expert's judgement of the items. This means that the experts agreed with the observations that were used to measure sensory integration.

Some significant moderate and weak correlations were found because of concurrent validity testing between the SIPT and the SASISI. Although higher correlations were suspected, a moderate correlation was experienced as positive and confirmed that the SASISI does measure sensory integration. More research is however needed to confirm this as the sample was very small.

Finally, Objective 3 showed that the sensitivity and specificity for the SASISI was high and that the instrument would be able to discriminate between children with or without sensory integration difficulties.

All objectives in the three phases were met and resulted in a screening instrument appropriate for children from low socio-economic environments. The initial findings are positive, but the overall conclusion is that more research on large samples is needed to confirm these findings and to refine the SASISI.

CHAPTER 8: FINAL CONCLUSION AND RECOMMENDATIONS

8.1 INTRODUCTION

The study set out to determine if a contextually appropriate screening instrument would provide a tool that can guide community occupational therapists in the identification of children from low socio-economic communities who are at risk of having sensory integration difficulties. This was done in three phases that aimed:

- To develop the items for the screening instrument identifying sensory integration difficulties in children of 5 years 0 months to 6 years 11 months from low socio-economic environments.
- To field test, refine and determine the internal construct validity and clinical utility of the newly developed sensory integration screening instrument on children 5 years 0 months to 6 years 11 months of age in low socio-economic environments.
- To establish additional psychometric properties of the newly developed sensory integration screening instrument.

This chapter summarises the findings and reports on the implications of the study for occupational therapists, the limitations of the study and recommendations for further research.

8.2 SUMMARY OF FINDINGS AND IMPLICATION FOR OCCUPATIONAL THERAPY

Phase one was successfully concluded with the **development of the SASISI**. Experts in sensory integration reached consensus on six activities for use as measures in the instrument. These activities were found to be age and cultural appropriate and were used successfully in other paediatric assessments of perception and developmental delay, although they were not measuring sensory integration per se. The activities were developed into measurable observable actions through the process of activity analysis. This process proved beneficial as the criteria set for instrument development could be addressed in the administration and scoring format. The administration and scoring system worked well and the occupational therapy research assistants commented on the ease of administration and scoring for most of the sensory integration domains. The use of the administration manual and the importance of attending a training programme prior to the use of the SASISI was discussed. A blended learning approach was selected as part of the design of the training programme as was found to be a successful cost-effective way of training.

Figure 8.1: The SASISI logo represents the six activities within the instrument

Implication of the findings in Phase one for occupational therapy: The SASISI is an age and culturally appropriate screening instrument that can be used in different clinic or public healthcare settings. Occupational therapists and children from diverse cultures are familiar with these activities. As the administration and scoring format was found to be easy to use, it will provide novice occupational therapists with a tool that can be easily learned and utilised within their workplace. The SASISI can however only be used following the completion of a formal training programme, as the researcher observed that not all occupational therapists have the same level of competence in using observations. As occupational therapists working in the public health sector have high workloads, this blended learning training programme will be easily accessible for occupational therapists. The process will take approximately an hour and will allow occupational therapists to study the instrument at home and they will only need to take off one day from work to attend the face-to-face session.

During Phase two, the SASISI was field tested to determine the internal construct validity. Initially a **pilot study** was undertaken to correct administration and scoring difficulties. This process revealed the influence of language on the instructions during administration of the instrument. Children who did not speak English found some of the instructions challenging. The researcher therefore developed a sheet with key instructions in six different languages for the activity instructions, which proved to be successful and was found to not only improve the administration of activities, but also ensure a more standardised way of giving instructions.

<u>Implication for occupational therapy</u>: To prevent unreliable outcomes in standardised assessment, it is important to assess children in their home language. Translators are not always available to assist occupational therapists in public healthcare settings. The development of the sheet with key instructions in six different languages will assist occupational therapists to administer the SASISI to all children without having to find a translator to assist.

The **sample** used for the research study consisted of children from low socio-economic environments in Gauteng and North West Province. The results from the HESSI questionnaire indicated that the sample population experienced similar difficulties as other low socio-economic populations in the literature. Environmental risk factors such as financial and material hardship, increased stress for children and parents, parenting difficulties, inadequate housing, poor parental education and health were identified and discussed.

<u>Implication for occupational therapy</u>: The OTPFIII emphasised the importance of investigating the child's context when compiling an occupational profile, and the above-mentioned findings highlighted the importance of doing a thorough assessment, so that these factors are not overlooked (AOTA, 2014).

Objective 2 in Phase two used the Rasch analysis to determine the **internal construct validity**, but unfortunately, the results were not as good as expected. Only the domains of object handling, and bilateral integration and sequencing showed appropriate Chi-square fit and therefore good internal construct validity. This indicates these domains discriminate well between the underlying sensory integration constructs.

The threshold ordering showed overall, the scoring of the SASISI using a Likert scale of 1 to 4 was effective to assess the child's ability and to affirm easy to difficult items. A negative finding was that the SASISI did not use a format where activities became increasingly more difficult as the scoring was based on observations.

Although the individual items score still fit in the expected range between ± 2.5, the individual items were not well targeted, i.e. not too hard or too difficult. In eight of the nine domains, no local dependency was found. This indicates that the items contribute individually towards the screening of the child's ability to complete the task without influencing other items. Differential item functioning was only found in the Visual form and space domain between the female and male scores for three subtests. This was a positive result, as the implications are that few of the items discriminate between boys and girls. The person separation index (PSI) was not achieved at all, although three of the domains namely Praxis, Visual Spatial and Organisation of self and behaviour were above 0.8 but not the required 0.85. In effect, the PSI values lower than 0.85 showed there was not a normally distributed sample rather than poor item functioning. Uni-dimensionality was reached for the Object handling, Sensory reactivity, Organisation of space and environment and the Organisation of self and behaviour domains with scores below the required 5%. This illustrates that these domains adhere to the requirements of the Rasch model and measure that for which they were designed.

<u>Implication for occupational therapy</u>: Occupational therapists need to choose valid and reliable assessments when assessing children. As the internal construct validity of the SASISI was doubtful, the occupational therapists need to be careful in the interpretation of the findings if they do use the SASISI in practice. Findings will need to be correlated with findings of other instruments providing information on sensory integration.

The findings from the **clinical utility testing** for Objective 3 provided positive results. The SASISI was found to be practical and appropriate for use in the low socio-economic context as activities are universal for various ages, gender and cultures. The occupational therapy research assistants found the SASISI easy to administer, and equipment was cost effective and easy to obtain. As the SASISI is straightforward and short to administer, the occupational therapist should be able to complete the assessment in less than an hour. The occupational therapy research assistants indicated the activities were easy to administer either through demonstration or by using the list of key terms for instructions. Children also found the activities fun to complete and were excited about taking an end-product home.

<u>Implication for occupational therapy</u>: The above findings illustrate the SASISI will be a suitable assessment for use by occupational therapists delivering services in public healthcare and the planned government ideal clinics. The easily obtainable and cost-effective equipment can either be bought by the facility or the occupational therapist can assemble her own kit.

As only a few pieces of equipment are needed, the occupational therapist can fit it in to a manageable bag for traveling between clinics in the community.

The short and easy to administer format is also ideal for use in a community setting, and the occupational therapist should be able to complete the assessment in less than an hour. This means the child does not have to visit to the occupational therapy department to complete the assessment and therefore not place unreasonable burden on the family and occupational therapy resources. The sheet with key instructions also aimed to minimise the burden on the occupational therapist, as well as assisting to make the SASISI user friendly to children from various parts of South Africa where different languages are spoken.

Phase three further investigated the psychometric properties of the SASISI, which included content validity testing, concurrent validity and sensitivity and specificity. The **content validity** indicated that South African experts in sensory integration agreed with the sensory integration observations being measured.

Implications for occupational therapy: Despite the disappointing internal construct validity, this was a positive outcome and shows the SASISI is measuring sensory integration, as intended. This means the occupational therapists in the community can be confident in using the SASISI to assess possible difficulties in sensory integration.

The **concurrent validity** testing showed significant moderate correlations between all the domains on the SASISI and some of the SIPT tests. Although the correlations were not high, the moderate correlations were positive in that they showed there were some relationships between the two instruments. Cermak and Murray (1991) reiterated that moderate to high correlations with an instrument that measure a similar construct is not necessarily a poor result as it indicates the new instrument is not duplicating the existing instrument.

Implications for occupational therapy: The Space Visualisation test and Praxis on Verbal Command tests illustrated the best moderate correlation with the SASISI. This is in line with the literature on child development within low socio-economic environments. Occupational therapists need to be cognisant of the fact that children growing up in these environments are prone to experience visual form and space difficulties and difficulties with the understanding of language. The moderate correlations of these two tests with the domains of the SASISI show that these domains will possibly be able to identify visual form and space and language difficulties.

The **sensitivity and specificity** of the SASISI were found to be high and the instrument is therefore able to identify children with possible sensory integration difficulties, preventing over diagnoses and servicing. High positive predictive scores were also found and confirmed that children identified as having sensory integration difficulties, the children truly have poor processing of sensory information.

Implication for occupational therapy: Glover and Albers (2007) explained that children who are under identified may miss out on occupational therapy services. This is especially important in the low socio-economic context, where access to occupational therapy services are problematic at the outset. The positive finding for sensitivity and specificity means that occupational therapists can use the SASISI with confidence to identify children with possible sensory integration difficulties within low socio-economic environments.

8.3 LIMITATIONS OF STUDY

The development of the SASISI included three phases with at least three objectives each. This made it quite a large study and limitations were anticipated.

The first limitation of Phase one was the use of a questionnaire with open-ended questions to collect qualitative data. This data collection technique provided limited information and a focus group or individual interviews could, in retrospect, have been used to gather more and richer information. The researcher found participants provided information on observations that could be used, but not on how they could be used or specific activities that could be used. Individual interviews would have allowed for more exploration of the answers.

Linked to this limitation was the low response rate of only 17%. A possible explanation for the poor response rate might be that the questionnaire was sent out at the end of a school year when occupational therapists are overwhelmed by completing therapy sessions before the holidays and writing progress reports. The timing of the survey was therefore a limitation and the timings should be taken into consideration in further research.

The findings from Phase two revealed several limitations. Firstly, the HESSI questionnaire was used to gather data on the sample population, however it was initially developed to gather data on poverty within large communities. The questions in the questionnaire focused on establishing the socio-economic status of the participant, rather than obtaining details on their household context, availability of toys and books, the family context or the mother's education and mental health, as described in the literature review.

By adding questions based on these factors to the questionnaire, information that is more detailed would be available especially on the children's stimulation and development in their early years. Although occupational therapists can tap into these types of information it would be more valuable if occupational therapists start collecting population data on aspects that matter for the profession and service delivery, including sensory environment, nature of play, space for play and toys, to name a few.

Another limitation of the study was the sample size for internal construct validity. The proposed sample size was 2003, but the actual sample consisted of 200 children from Gauteng and North West Province. This was because only 200 of the children from the selected schools qualified for inclusion in the study. Anthoine et. al. (2014) found there was no consensus on how to determine the sample size in the development of a measurement instruments, whilst Streiner and Kottner (2014) proposed that a sample size should include at least 10 participants per variable. Unfortunately, the SASISI had nine domains with a total of 332 items and would have required a sample size of 3320 children. This was not a realistic sample size for the development phase, as the timeframe available for assessment was short and only five occupational therapy research assistants available. Yamane (1967) calculation for sample size was used to determine the sample size for the construct validity. The population sample that was used in the calculation was based on the number of children available in Johannesburg and Potchefstroom who were, at the time of the research, in grade R and grade 1. The effect of the small sample size was evident in the Rasch analysis, as the internal content validity was poorer than expected. More research on large samples is however necessary to determine problems in item functioning and scoring accuracy. The person separation index, which is an indication of the reliability of the instrument, is sample dependent and may improve in larger samples (Bond and Fox, 2015).

The small sample size for the concurrent validity in Phase three was also a limitation. The sample size was set at n = 36, based on the literature of previous studies of concurrent validity for the SIPT (Israel, 1992). Unfortunately, only a small sample of n = 28 children were included in the testing. The execution of SIPT testing in the time available was problematic and could only be done by occupational therapists who had completed their training in sensory integration. Three of the five occupational therapists assisting with the SIPT testing worked in private practice and were only available for specific days and times to assist with the testing. A bigger sample size (Kielhofner, 2006b) would provide more information on the relationships between the SASISI and the SIPT and significance of these relationships.

8.4 RECOMMENDATIONS

More research with bigger sample sizes are needed to investigate and refine the psychometric properties of the SASISI. Research with bigger samples will result in samples that have more normal distributions. This will in turn improve the internal construct validity and specifically, the person separation index that is sample dependent. Using the sample method for instrument development as earlier discussed, a sample of more than n = 3000 children would provide valuable information. As this research project was just the beginning of the instrument development the researcher would urge occupational therapists in the community to participate in the next step of the instrument development journey. This was also a first in terms of developing an instrument for identifying children growing up in low socio-economic environments, with possible sensory integration difficulties.

Further research on the SASISI is also needed to determine the normative data for this population of children.

Although the SASISI is now ready for use in the public healthcare sector and clinics, it is important to gather data from other instruments as well. The researcher recommends that occupational therapists include the use of the Ayres Clinical Observations (SAISI Research Committee, 2005), as well as a sensory history questionnaire, e.g. the Sensory Profile (SP) (Dunn, 2014) or the Sensory Processing Measure (SPM) (Parham et. al., 2007), during assessment. The interpretation of these assessments should be discussed with a trained sensory integration therapist to ensure that outcomes are valid and reliable. The SASISI provides information on the observations of sensory integration during the execution of activities but does not include enough information on the performance components as seen in the Ayres clinical observation or the sensory reactivity measured by the SP or SPM.

A literature review and provisional data from this study indicated a noticeable presence of sensory integration difficulties in children from low socio-economic environments. More research on larger samples would contribute to the already existing body of knowledge on this vulnerable population. Occupational therapists should however not only assist in identifying the difficulties, but also contribute to exploring pathways of care for children identified with sensory integration difficulties. These findings provide valuable support to the importance of advocating for stimulation programmes rich in sensory integration opportunities from an early age. Possible interventions could include linking and collaborating with the rest of the healthcare team to provide information and insight on sensory integration and the influence on healthcare and child development and to promote referral to occupational therapy.

As child development and the development of sensory integration is influenced by environmental factors, such as the mother's level of education, parenting skills and availability of stimulating environments, early interventions should also focus on parent training. The occupational therapist working in the public healthcare clinics has the opportunity to design and present early intervention programmes, where mothers who bring their babies for check-ups and immunisations can be included in stimulation groups. The ideal would be for the Road to Health booklet, received by a baby at birth, to include compulsory visits to the occupational therapist for the first year of life.

8.5 FINAL CONCLUSION

The use of sensory integration as an approach has always been a passion as it provides such a rich foundation that is supported by research on children and their development. Working in the public healthcare sector, I became acutely aware of the fact that children from low socio-economic environments are frequently referred to occupational therapists with occupational performance difficulties reflecting sensory integration difficulties. The use of a sensory integration approach involves advance training and knowledge that cannot be simplified or used in a simplistic way. The identification of these difficulties is frequently missed by community occupational therapists working in low socio-economic communities as they only have basic knowledge of sensory integration theory.

The aim of the SASISI is not to provide community service occupational therapists with basic sensory integration knowledge, but to enable them to assess children using a simple cost-effective tool to determine if they were at risk of having sensory integration difficulties. The instrument was deliberately developed in such a way that the community service therapist only needs to observe the child's participation and that the developed scoring format will provide information on the sensory integration domains at risk. Although the initial instrument is not psychometrically as strong as I would have liked, this now provides a starting to point for further research. The SASISI is now available for use in the community and my dream is that it will enable community occupational therapists to assess and assist children in the community with a tool that is appropriate for the context.

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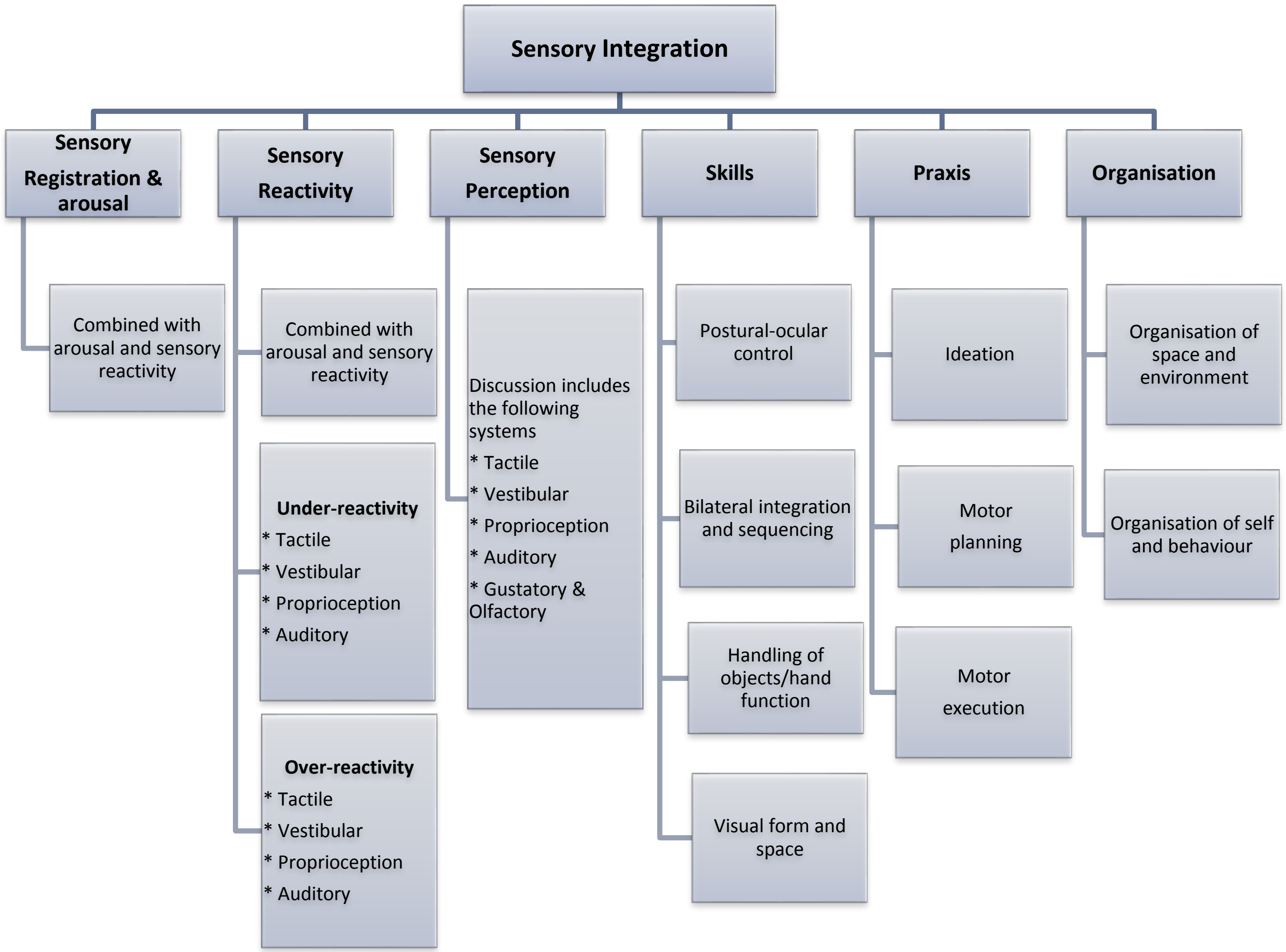
APPENDIX A: CLARIFICATION OF THE SENSORY INTEGRATION COMPONENTS INCLUDED IN THE SCREENING INSTRUMENT AS DOMAINS

The sensory integration domains are based on the key components of sensory integration as described by Smith Roley and Schaaf (Smith Roley and Schaaf, 2006).



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CLARIFICATION OF TERMS FOR THE SENSORY INTEGRATION DOMAINS

SENSORY REACTIVITY OR MODULATION			
Area described		**Description of term (the role and function)**	**Possible functional observations during testing that can be indicative of difficulties**
Arousal		*This process answers the question of what is to be done. This is a psychological state of being awake and reactive to stimulation.*	❖ Is the child's activity level appropriate to task (not too high, or too low)? ❖ Is the child showing any autonomic nervous system reactions, e.g. increased? respiration, hyperventilation, flushing, pallor, sweating, change in pupil size? ❖ Is the child struggling to focus on the task at hand? ❖ Is the child showing signs of being anxious and overwhelmed?
SENSORY REACTIVITY OR MODULATION (Smith Roley et. al., 2001a; Bundy et. al., 2002; Ayres, 2005)		*Smith Roley et. al. (2001a: 57) describe sensory modulation in behavioural terms as: "the ability to regulate and organise responses to sensation in a graded and adaptive manner, congruent with situational demands."* *McIntosh et. al. (1999a: 608) describe sensory modulation as: "the capacity to regulate and organise the degree, intensity and nature of responses to sensory input in a graded and adaptive manner."* *Recently the term sensory modulation was changed to sensory reactivity (Schaaf and Mailloux, 2015).*	❖ Is the child's level of arousal appropriate for the activities? ❖ Is the child's behaviour disorganised or inappropriate for the activity? ❖ Is the child showing any of the following emotional reactions? ➢ Expressing discomfort verbally, (I am tired). ➢ Tries to opt out of the situation (when are we finished?). ➢ Body language indicators, for e.g. pulls away or move away from the therapist. ➢ The child verbally indicates that he/she does not want to participate (I do not want to do this). ➢ The child exhibits negative emotions that are directly related to participation in the activity. ❖ Is the child distractible during the activity with decreased concentration? ❖ Is the child becoming restless during the activity and start to move around in the chair or want to stand up? ❖ Is the child showing any flight, fright or fight reactions?

			<table><tr><th>Flight reaction</th><th>Fright reaction</th><th>Fight reaction</th></tr><tr><td>➢ Verbal and non-verbal avoidance behaviour. ➢ Appears to be the class clown, making jokes. ➢ Becomes restless ➢ Constantly changing positions. ➢ Often asks to go to the bathroom or to have a drink of water to avoid participating.</td><td>➢ May appear reluctant to communicate. ➢ May seem shy. ➢ Finds it difficult to focus on a task. ➢ Complains about getting hurt or indicate that they are unable to do the task when asked to participate.</td><td>➢ Appears to be aggressive. ➢ Use negative or resistive behaviour and language. ➢ The child becomes agitated.</td></tr></table> ❖ Are the child's facial expressions showing discomfort, e.g. grimacing, eyes showing discomfort, become too serious?

SENSORY REACTIVITY OR MODULATION IN DIFFERENT SYSTEMS				
Area described		**Description of term (the role and function)**	**Possible functional observations during testing that can be indicative of difficulties**	
			VISUAL UNDER RESPONSIVE	**VISUAL OVER RESPONSIVE**
Sensory reactivity or modulation in sensory systems (Murray-Slutsky and Paris, 2000; Smith Roley et. al., 2001a; Bundy et. al., 2002)	**Visual system**	*The sensation from the visual system provides information through the eyes about what we see and plays a role in anticipating what is going to happen in the environment.*	➢ The child does not seem to notice objects on the table during the tabletop activities. ➢ Does not seem to notice objects in the room and will even bump into them. ➢ The child does not see important visual cues in the environment even though visual acuity is normal.	➢ The child seems oversensitive to bright light during the activities. ➢ Objects in the environment easily visually distract the child. ➢ May avoid eye contact with the therapist. ➢ The child may frequently put hands in front of their eyes or squint. ➢ The child has difficulty maintaining visual focus on the activities. ➢ The child frequently rubs his/her eyes or has watering eyes.

See full document in attached memory stick

APPENDIX B: HUMAN RESEARCH ETHICAL COMMITTEE

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Ms Janine van der Linde

CLEARANCE CERTIFICATE	**M120359**
PROJECT	The Development of a Screening Instrument to Identify Sensory Integration Difficulties in Children from Low Socio Economic Environments
INVESTIGATORS	Ms Janine van der Linde.
DEPARTMENT	Department of Occupational Therapy
DATE CONSIDERED	30/03/2012
DECISION OF THE COMMITTEE*	Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 29/06/2012 **CHAIRPERSON** ....
(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable
cc: Supervisor : Daleen Castelijn

DECLARATION OF INVESTIGATOR(S)
To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES...

APPENDIX C: INFORMATION LETTER TO EXPERT PANEL

University
of the Witwatersrand,
Johannesburg

Department of Occupational Therapy

[illegible]

24 August 2012

Dear Occupational therapist

I am Janine van der Linde; an Occupational Therapist trained in Sensory integration and working at Wits University as a lecturer. I am currently completing a research project for a PhD degree in Occupational Therapy, at the University of the Witwatersrand in South Africa. The aim of the research project will be to develop a screening instrument that will identify children at risk of having difficulties with processing and integrating sensory information in 5-6 year old children from low socio economic environments. I would be most grateful if you would consider participating in this study by completing the attached questionnaire.

Why am I doing this study?

A recent report by UNICEF indicated that child poverty in South Africa is among the highest in the world with two thirds of children (approximately 61 %) living in poverty.(1)

Young children that grow up in low socio economic environments are at risk of developing developmental delay, cognitive, social and behavioural difficulties. It is also suspected that children from more challenging environments e.g. low socio economic will have more difficulties in sensory integration and thus impacting negatively on development.(2)

A literature review indicated only a few studies in South Africa that looked at the prevalence of sensory integration difficulties in low socio economic environments(3, 4). A study was done by Van Jaarsveld (2001) who found that there is a significant prevalence of sensory integration difficulties in children from a low socio economic background.(3) In four small studies done by students from the University of the Freestate it was further found that there is a statistical significant difference between children from high and low socio economic areas in regards to sensory integration difficulties.(4)

Unfortunately the identification of sensory integration difficulties in children from low socio economic environments in South Africa are quite rare and in some areas of the country even non-existent. Occupational therapy services within the community are largely provided by newly qualified community service therapists.(4) They have basic knowledge of sensory integration difficulties, as the use of Sensory integration assessment and treatment requires post graduate training and knowledge and can only be provided by a therapist who has completed this specialised post graduate course.(5)

Access to an Occupational therapist (OT) with specialised knowledge in sensory integration is therefore very limited for children from low socio economic status (SES), as according to a survey by the South African Institute for sensory integration 40% of these qualified sensory integration therapists are working in private practice.(6)

A further problem to access this service, is that the Gold standard assessment, the Sensory Integration and praxis test (SIPT)(7) is expensive and need specialised training to use and is therefore financially not viable in a community or a government setting.

In order to make these services more accessible to children from low socio economic environments a solution for this problem could be to develop a short cost effective screening instrument for use by the community service therapist in order to identify children at risk of sensory integration difficulties.

It is therefore important to empower community service therapists to be able to identify children at risk of having sensory processing and integration difficulties. A solution could be to provide a short and cost effective screening instrument that can assist the community service therapist to identify children at risk of having difficulty to process and integrate sensory information from the environment.

The community service therapist who is empowered with basic knowledge on SI and who does have a screening instrument that is valid, reliable and cost effective for the population, will then be able to refer the child for further assessment or implement a sensory integration stimulation program within the community/home/school to encourage sensory integration.

I am working towards consensus between occupational therapists on what items should be included in the screening instrument and am therefore using the Delphi method to gather information. This is the first round of data collection. There will be second and perhaps third round questionnaires, depending on how soon consensus is reached.

I would appreciate your input into this screening instrument and would like to ask you to complete this questionnaire. You can contact me on 0835640375 or by email on janinevdl1@gmail.com OR Janine.vanderLinde@wits.ac.za if you have any further questions. For any other questions regarding this study please contact the Human Research Ethics Committee (HREC) chairperson Prof P Cleaton-Jones on (011)7171234 or at anisa.keshav@wits.ac.za.

This study has been approved by the University of the Witwatersrand Human Research Ethics Committee (Medical). Approval nr: **M120359**

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APPENDIX D: DELPHI PROCESS: FIRST ROUND QUESTIONNAIRE

APPENDIX D FIRST ROUND QUESTIONNAIRE

INSTRUCTIONS FOR COMPLETION

PART 1: BACKGROUND INFORMATION OF THE OCCUPATIONAL THERAPIST COMPLETING THE FORM

1.1. Question 1:

Please highlight the area that indicates your years of experience in Occupational therapy

1.2. Question 2:

Please highlight the area that indicates your years of experience in sensory integration.

1.3. Question 3:

Please indicated your HIGHEST level of education

1.4. Question 4:

Please indicate your HIGHEST level of training in Sensory integration

1.5. Question 5:

Please indicate your involvement in Sensory integration activities.

PART 2: ASSESSMENT OF SENSORY INTEGRATION

2. Please describe what activities you will use to observe/assess sensory integration difficulties in the different areas of sensory integration. Name at least 3 or more activities in each area.

Remember that these assessments will be performed by Community Service Occupational therapists and need to be simple and cost effective without the need for any expensive equipment.

PART 3: ADMINISTRATION ISSUES

Please describe how many items you think the screening instrument should consist of.

Please describe what scoring system will be beneficial to use.

FIRST ROUND QUESTIONNAIRE

PART 1: BACKGROUND INFORMATION ON THE CLINICIAN COMPLETING THE FORM

Question 1: Please **highlight** the area that indicates your years of experience in Occupational therapy.

Years' experience in Occupational therapy	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
	11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
	21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**

Question 2: Please **highlight** the area that indicates your years of experience in sensory integration.

Years' experience in Sensory integration	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
	11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
	21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**

Question 3: Please indicate your **HIGHEST** level of education, by highlighting the correct box.

Highest qualification in Occupational therapy	**Bachelors**	**Masters**	**PhD**	**Professor**
Please name any other formal qualifications:				

Question 4: Please indicate your **HIGHEST** level of training in sensory integration, by highlighting the correct box.

Highest level of training in sensory integration	**Theory**	**Test Admin**	**Interpretation**	**Treatment**
Any other training in sensory integration:				

Question 5: Please indicate your involvement in Sensory integration activities, by highlighting the correct box

Involvement in sensory integration	**Protocol marker**	**SAISI** **Lecturer**	**SAISI board member**	**SAISI board** **Exco member**
Please name any other formal qualifications:				

PART 2: ASSESSMENT OF SENSORY INTEGRATION

QUESTION 1: Please describe what activities you will use to observe/assess sensory integration difficulties in the sensory systems.

SENSORY SYSTEMS
VISUAL SYSTEM
VESTIBULAR SYSTEM
PROPRIOCEPTIVE SYSTEM
TACTILE SYSTEM
AUDITORY SYSTEM

QUESTION 2: Please describe what activities you will use to observe/assess sensory modulation difficulties in the sensory systems.

SENSORY MODULATION
VISUAL SYSTEM
VESTIBULAR SYSTEM
PROPRIOCEPTIVE SYSTEM
TACTILE SYSTEM
AUDITORY SYSTEM

QUESTION 3: Please describe what activities you will use to observe/assess sensory discrimination difficulties in the sensory systems.

SENSORY DISCRIMINATION
VISUAL SYSTEM
VESTIBULAR SYSTEM
PROPRIOCEPTIVE SYSTEM

TACTILE SYSTEM
AUDITORY SYSTEM

QUESTION 4: Please describe what activities you will use to observe/assess motor skills difficulties du to sensory integration difficulties.

MOTOR SKILLS
POSTURAL-OCCULAR DIFFICULTIES
BILATERAL INTEGRATION DIFFICULTIES
SEQUENCING DIFFICULTIES
OTHER

QUESTION 5: Please describe what activities you will use to observe/assess praxis difficulties du to sensory integration difficulties.

PRAXIS
IDEATION
MOTOR PLANNING
VISUO PRAXIS
SOMATODYSPRAXIA
OTHER

ANY OTHER INFORMATION THAT YOU WOULD LIKE TO ADD?

PART 3: ADMINISTRATION ISSUES

Please describe how many items you think the screening instrument should consist of and why?
Please describe what scoring system will be beneficial to use.
Any other administrative issues that should be kept in mind?

THANK YOU FOR TAKING THE TIME TO COMPLETE THIS QUESTIONNAIRE!

APPENDIX E: DELPHI PROCESS: SECOND ROUND QUESTIONNAIRE

RESEARCH JVD LINDE_12_02_2013

Good day

I will really appreciate it if you can assist me with my PhD study by completing this survey.

As part of my PhD, I am currently busy developing a screening instrument for Sensory integration difficulties for 5 – 6 years 11-month-old children from low socio-economic areas. There are many checklists available with certain behaviours that can be indicative of Sensory integration difficulties. I would however like to look at more functional tasks or Occupational Performance areas that can be used to observe these difficulties.

I have included items from the literature, developmental checklists and other tests that may possible be used to provide information regarding SI difficulties.

<u>The activities on the lists were chosen for the following reasons:</u>

1. The activities require very little equipment. There is no SI equipment available in the communities, so we will not be able to use this.

2. The activities are appropriate for the age group.

3. It is appropriate for low socio-economic environments, considering culture and possible lack of exposure to certain items

Please click on the activity/activities that you feel will give the most information on possible SI difficulties when the child is being observed doing that activity.

Then please describe what behaviours/SI components you will be able to identify or suspect as being problematic when looking at this, for e.g. cutting - bilateral integration, motor planning etc.

1. Which activity/activities of daily activity/activities will provide the most information regarding sensory integration difficulties?

☐ Dressing (putting on a T-shirt)	☐ Putting on socks and shoes	☐ Washing and drying Face
☐ Undressing (taking of a T-shirt)	☐ Eating porridge	☐ Brushing teeth
☐ Dressing and undressing (T-shirt)	☐ Washing and drying hands	☐ Brushing hair

Other (please specify)

2. What observations/behaviours indicating SI difficulties can be made during this activity?

3. Which play activity/activities will provide the most information regarding sensory integration difficulties?

- ☐ House hold games
- ☐ Construction game with blocks
- ☐ Board game
- ☐ Threading beads
- ☐ Drawing shapes in mud
- ☐ Making a mud pot
- ☐ Painting hand prints
- ☐ Making clay shapes

Other (please specify)

4. What observations/behaviours indicating SI difficulties can be made during this activity?

5. Which school type activity/activities will provide the most information regarding sensory integration difficulties?

- ☐ Cutting with scissors
- ☐ Drawing with a pencil
- ☐ Doing a simple maze pattern
- ☐ Matching game
- ☐ Colouring In
- ☐ Simple Puzzle 30 pieces
- ☐ Sorting of objects
- ☐ Imitates building a block construction
- ☐ Threading with beads
- ☐ Tie a bow
- ☐ Posting buttons
- ☐ Copies clay forms

Other

6. What observations/behaviours indicating SI difficulties can be made during this activity?

7. Which motor games will provide the most information regarding sensory integration difficulties?

- ☐ Stand on one leg
- ☐ Walk Heel toe on a line
- ☐ Jump with both feet together
- ☐ Star jumps
- ☐ Hop scotch
- ☐ Throwing and catching a large ball
- ☐ Throwing and catching a tennis ball
- ☐ Bounce a tennis ball with one hand
- ☐ Throw a ball at a target
- ☐ Balloon volleyball

Other (please specify)

8. What observations/behaviors indicating SI difficulties can be made during this activity?

9. Any other information or ideas that you would like to add?

Thank you for assisting me with this questionnaire.

APPENDIX F: INITIAL MANUAL FOR SASISI

South African Sensory Integration Screening Instrument

SASISI

Screening Instrument

Compiled by: Janine van der Linde

July 2014

See full document in attached memory stick

APPENDIX G: TRAINING PROGRAM FOR THE SASISI

SOUTH AFRICAN SENSORY INTEGRATION SCREENING INSTRUMENT TRAINING

PLEASE NOTE

This training program is in an electronic format to allow you to access information at any time and as many times as you would like.

Within this electronic format, I will be able to see your data "footprint" in other words, how many times you did access the site and the specific areas within the site.

This information may be used for research purposes in future. No personal data will be used. Please let me know if you would not like your data footprint to be included in the research.

News forum

DOCUMENTS

Basic documents for use with the SASISI test.

PLEASE NOTE:

You are allowed to print these documents for training purposes or for assessment of children within the research project.

You are not permitted to print or use these documents for personal use or for use within your workplace without the written permission of the author.

SASISI Manual File

Scoring Sheet File

- SASISI Background information form File
- SASISI Teacher questionnaire form File
- SASISI Socio Economic Status Form File

BACKGROUND

On completion of the topic, the learner should be able to:

Discuss the reasons for the development of the screening instrument.

The extend of low SES in South Africa.

Basic sensory integration theory and definitions.

INTRODUCTION File

A short introduction on the South African Sensory Integration Screening Instrument (SASISI). Listen to the introduction before starting the lesson.

LESSON: Background on the development of the SASISI

ADMINISTRATION & SCORING OF SASISI

On completion of the topic, the learner should be able to:

Describe the equipment that is needed for each item.

Describe the structuring for the activity

Describe the test administration and instructions for each item.

Describe the overall scoring system.

Describe the different observations that can be scored in the test.

ADMINISTRATION AND SCORING OF SASISI Lesson

1. Administration and scoring of dressing & undressing File

2. Administration and Scoring of Heel toe walking File

3. Administration and Scoring Star jumps File

4. Administration & Scoring Block Activity File

5. Administration and Scoring Clay activity File

6. Administration and Scoring Cutting Activity File

CASE STUDIES FOR SCORING OF SASISI

Videos of three case studies for more in-depth practice of scoring.

These case studies form part of the assignment and the score sheets should be submitted for marking.

ETHICAL ISSUES

On completion of the topic, the learner should be able to:

Describe what ethical research behaviour entails.

Describe how this study adhere to the ethical guidelines.

Describe the ethical criteria discussed by the University of the Witwatersrand.

PRESENTATION: Ethics File

Please go through this presentation of ethics to ensure that you are up to date with the ethical issues in research and within this project. You will be asked to answer some questions in the quiz that relates to this presentation.

Research Ethics File

Please watch the short video on research ethics as this will give you an introduction into the world of ethics within research.

ASSESSMENT OF KNOWLEDGE

In order to ensure reliability of data collection and to show that proper training was done, I need to assess your knowledge. Please complete the quiz and hand in the assignment on the scoring of the child. Thank you. Janine

ASSESSMENT OF KNOWLEDGE SASISI Quiz
Please complete the short quiz to test your knowledge on the administration, scoring and ethical issue involved in the development of the SASISI.

ASSIGNMENT FOR HAND IN: Scoring Sheets for Video's Assignment
Please watch the videos of the scoring. Complete the scoring sheet for each child and submit it via this assignment.

APPENDIX H: CHECKLIST FOR PILOT TESTING

ADMINISTRATION	Child 1	Child 2	Child 3	Child 4	Child 5	Child 6
1. Ease of administration						
• Dressing & Undressing						
• Walking heel-toe						
• Star jumps						
• Construction with blocks						
• Clay game						
• Cutting with scissors: spider cutting						
2. Appropriate instructions						
• Dressing & Undressing						
• Walking heel-toe						
• Star jumps						
• Construction with blocks						
• Clay game						
• Cutting with scissors: spider cutting						

3. Appropriate equipment						
• Dressing & Undressing						
• Walking heel-toe						
• Star jumps						
• Construction with blocks						
• Clay game						
• Cutting with scissors: spider cutting						
4. Ease of scoring						
• Dressing & Undressing						
• Walking heel-toe						
• Star jumps						
• Construction with blocks						
• Clay game						
• Cutting with scissors: spider cutting						

5. Appropriateness of observations for scoring						
• Dressing & Undressing						
• Walking heel-toe						
• Star jumps						
• Construction with blocks						
• Clay game						
• Cutting with scissors: spider cutting						
Other observations or difficulties						

APPENDIX I: LANGUAGE SHEET WITH KEY TERMS

GENERAL PHRASES

English	isiZulu	isiXhosa	SeSotho	Tswana	Afrikaans
My name is	Igama lami ngu	igama	leibutso	leina	My naam is
Come play	uze play	dlala	bapala	tsameka	Kom speel
Going to do work	azoyenza emsebenzini	Enza sebenza	Etsa sebetsa	dira	Gaan werk doen
Shoes off	izicathulo off	isihlango	seeta	seeta	Skoene uit
Shoes on	izicathulo on	isihlango	seeta	seeta	
Stand here	ume lapha	Ma apha	Ema mona	Ema fa	Staan hier
Good work	umsebenzi omuhle	Sebenza kakuhle	Sebetsa hantle	Dira pila	Goeie werk
That's right	kulungile	lungile	nepileng	siame	Dis reg

DRESSING/UNDRESSING

English	isiZulu	isiXhosa	SeSotho	SeTswana	Afrikaans
Take off	Suka	thata	nka	tsaya	Haal af
Undress	khumula izingubo	khulula	hlobola	apola	Trek uit
Putt on	Faka	beka	bea	baya	Sit aan
Dress	sigqoka	nxiba	apesa	apara	Trek aan
Shirt	Lishethi	ihempe	hempe	hempe	hemp
Jersey	ijezi	ijeze	jeresi	jeresi	trui
look	bhekani	jonga	tadima	leba	kyk
feel	bazizwa	vakalelwa	ama	utlwa	voel
Do this	ukwenza lokhu	enza	etsa	dira	Doen dit

WALK HEEL-TOE

English	isiZulu	isiXhosa	SeSotho	SeTswana	isiAfrikaans
watch	qaphela	qwalasela	disa	lepa	kyk
You do	uyenza	Wena enza	Wena etsa	Wena dira	Doen jy
You try	uzama	uzama	leka	leka	Probeer jy
Close eyes	Amehlo close	Kufutshane iliso	Haufi leihlo	Gaufi leitlho	Oe toe
Feet together	izinyawo ndawonye	Unyawo sanke	Leoto hammoho	Lenao mmogo	Voete teen mekaar
Heel toe	isithende uzwane	Isithende uzwane	Serethe manwana wa leoto	Serethe monwano	Hak toon
walk	uhamba	uhumba	tsamaya	tsamaya	loop
Walk backwards	uhambe uye emuva	Uhumba buya	Tsamay marao	Tsamaya morago	Loop agter uit

STAR JUMPS

English	isiZulu	isiXhosa	SeSotho	SeTswana	Afrikaans
Watch me	Qaphela me	jonga	rasite	tshupatefo	Kyk vir my
You do	uyenza	Wena enza	Wena etsa	Wena dire	Doen jy
You try	uzama	uzama	leka	leka	Probeer jy
Jump like this	bagxume njengalona	xsiba	tlola	tlola	Spring so
arms	izingalo	ingalo	letsoho	lebogo	arms
Do it fast	ukukwenza fast	kwawulezayo	Etsa phakisang	Ka bonako	Doen dit vinnig
Keep on doing it	qhubekani nikwenza	qhubeka	Twela pele	letela	Hou aan
more	ngaphezulu	ngaphezulu	hape	gape	Nog
again	futhi	kwakhena	hape	gape	Weer

CONSTRUCTION WITH BLOCKS

English	isiZulu	isiXhosa	SeSotho	SeTswana	Afrikaans
Find the blocks	ukuthola amabhulokhi	famana	fumana	bona	Soek die blokkie
six	eziyisithupha	isithandathu	Tsjelela	borabona	ses
You build	wakha				
Look at the picture	ukubheka isithombe	Jonga umfanekiso	Tadima setshwantsho	Leba setshwantsho	Kyk na die prentjie
Try again	Zama futhi	Zama kwakhona	Leka hape	Leka gape	Probeer weer

CLAY GAMES

English	isiZulu	isiXhosa	SeSotho	SeTswana	Afrikaans
Roll a ball	Roll ibhola	ibhola	bolo	kgwele	Rol n bal
Between hands	emkhatsini izandla	isandla	seatla	seatla	Tussen jou hande
Roll a worm	Roll isibungu	impethu	seboko	seboko	Rol ‘n wurm
Hands on table	izandla phezu kwetafula	Isandla itafile	Seatla tafole	Seatla tafole	Sit jou hande op die tafel
Feel this	bazizwa ngale				
Draw this	udwebe le				
Draw this on hand	udwebe le esandleni				
Draw the same					

CUTTING WITH SCISSORS: Spider

English	isiZulu	isiXhosa	SeSotho	SeTswana	Afrikaans
What is this	**Kuyini lokhu**				**Wat is di**
Colour in	**umbala in**	**Umbala in**	**mmala**	**mmala**	**Kleur in**
spider					**Spinnekop**
head	**Ikhanda**	**intloko**	**hlaoho**	**tlhogo**	**Kop**
Eyes	**amehlo**	**iliso**	**leihlo**	**leihlo**	**Oe**
mouth	**Umlomo**	**umlomo**	**molomo**	**molomo**	**Mond**
Cut out	**ukuphuma**	**sika**	**seha**	**sega**	**Knip uit**
Cut on line		**umtya**	**Kgwele**	**mothalo**	**Knip op die lyn**
fold	**phinda**				**Vou**
scissors	**sikelo**	**iskere**	**sekere**	**sekere**	**Sker**
Make a plan	**yenza uhlelo**	**icebo**	**leqheka**	**leano**	**Maak 'n plan**
Thank you	**Ngiyabonga**	**umbelelo**	**diteboho**	**leboho**	**dankie**

PLEASE NOTE:

It may be possible that these words are not grammatically correct and should only serve as a guide to assist with instructions NOT as a substitute for instructions.

APPENDIX J: PERMISSION FROM THE GAUTENG DEPARTMENT OF EDUCATION

GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

For administrative use:
Reference no: D2014 / 375

GDE RESEARCH APPROVAL LETTER

Date:	**3 March 2014**
Validity of Research Approval:	**3 March to 3 October 2014**
Name of Researcher:	**Van der Linde J.**
Address of Researcher:	**P.O. Box 2659**
	Potchefstroom
	2520
Telephone Number:	**011 717 3272 / 083 564 0375**
Email address:	**Janine.vanderLinde@wits.ac.za**
Research Topic:	**The development of a screening instrument to identify sensory integration difficulties in children from low socio-economic environments**
Number and type of schools:	**ONE HUNDRED AND THIRTY-NINE Primary Schools**
District/s/HO	**Johannesburg East; Johannesburg South; Johannesburg West; Johannesburg North; Ekurhuleni East and Ekurhuleni West.**

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

2014/03/05

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Making education a societal priority

Office of the Director: Knowledge Management and Research
9th Floor, 111 Commissioner Street, Johannesburg, 2001
P.O. Box 7710, Johannesburg, 2000 Tel: (011) 355 0506
Email: David.Makhado@gauteng.gov.za
Website: www.education.gpg.gov.za

The following conditions apply to GDE research. The researcher may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

1. *The District/Head Office Senior Manager/s concerned must be presented with a copy of this letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.*
2. *The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.*
3. *A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.*
4. *A letter / document that outlines the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.*
5. *The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.*
6. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
7. *Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year. If incomplete, an amended Research Approval letter may be requested to conduct research in the following year.*
8. *Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.*
9. *It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.*
10. *The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.*
11. *The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.*
12. *On completion of the study the researcher/s must supply the Director: Knowledge Management & Research with one Hard Cover bound and an electronic copy of the research.*
13. *The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.*
14. *Should the researcher have been involved with research at a school and/or a district/head office level, the Director concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.*

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

Makhado
....

Dr David Makhado
Director: Education Research and Knowledge Management

DATE: 2014/03/05

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Making education a societal priority

Office of the Director: Knowledge Management and Research
9th Floor, 111 Commissioner Street, Johannesburg, 2001
P.O. Box 7710, Johannesburg, 2000 Tel: (011) 355 0506
Email: David.Makhado@gauteng.gov.za
Website: www.education.gpg.gov.za

APPENDIX K: PERMISSION FROM THE NORTH-WEST PROVINCE DEPARTMENT OF EDUCATION

11/04 2014 05:38 FAX 0182998290 E M South Region 001/001

education
Lefapha la Thuto la Bokone Bophirima
Noord-Wes Departement van Onderwys
North West Department of Education
NORTH WEST PROVINCE

Tyrone Building
6 O.R. Tambo Street, Potchefstroom
Private Bag X1256
Potchefstroom 2520
Tel: (018) 299-8276
Fax: (018) 294-8234
Enquiries: Mr H. Motara
e mail: hmotara@nwpg.gov.za

DR KENNETH KAUNDA DISTRICT
SENIOR PROFESSIONAL SUPPORT MANAGER

10 April 2014

Ms J van der Linde
Occupational Therapy Department
University of the Witwatersrand

PERMISSION TO CONDUCT RESEARCH ON "OCCUPATIONAL THERAPY" IN SECONDARY AND PRIMARY SCHOOL IN MATLOSANA AREA OFFICE, MAQUASSI HILLS AREA OFFICE AND TLOKWE AREA OFFICE - DR KENNETH KAUNDA DISTRICT

The above matter refers.

Permission is hereby granted to you to conduct your research in secondary and primary schools in Matlosana Area Office, Maquassi Hills Area Office and Tlokwe Area Office - Dr Kenneth Kaunda District under the following provisions:

- **The activity you undertake at the schools should not tamper with the normal process of learning and teaching; and will take place after school hours.**
- **You inform the principals of your identified school of your impending visit and activity;**
- **You provide my office with a report in respect of your findings from the research; and**
- **You obtain prior permission from this office before availing your findings for public or media consumption.**

Wishing you well in your endeavour.

Thanking you

MR H MOTARA
DISTRICT DIRECTOR
DR KENNETH KAUNDA DISTRICT

cc: *Mr S S Mogotsi – Area Manager, Matlosana*
Mr A J Engelbrecht – Area Manager, Maquassi Hills
Mr M Mogale – Acting Area Manager, Tlokwe

APPENDIX L: INFORMATION LETTER TO HEAD MASTERS OF EACH SCHOOL

Occupational Therapy

School of Therapeutic Sciences • Faculty of Health Sciences • 7 York Road, Parktown 2192, South Africa
Tel: +27 11 717-3701 • Fax: +27 11 717-3709 • E-mail: denise.franzsen@wits.ac.za

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

Janine van der Linde
Occupational therapy department
7 York Road
Parktown
2192

10/07/2014

The Head teacher/Governing body

Dear Sir/Madam

<u>RE: PhD research study at school/centre</u>

I am Janine van der Linde, a Lecturer in Occupational Therapy/E-Learning at the University of the Witwatersrand in Johannesburg. I am currently completing a research project for a PhD degree in Occupational Therapy, at the University of the Witwatersrand. The aim of the study is to develop a screening instrument that will identify children at risk of having difficulties with processing and integrating sensory information in five to six year 11 month old children from low socio economic environments in the Gauteng and the North West province. I would be most grateful if you would consider participating in this study by giving permission for the researcher to assess all children with parental permission of five to six years 11 months, within Grade R and Grade 1 in your school.

Why am I doing this?

A recent report by UNICEF indicated that child poverty in South Africa is among the highest in the world with two thirds of children (approximately 58 **%**) living in poverty.(Jamieson et. al., 2011). Young children that grow up in low socio-economic environments are at risk of developing developmental delay, cognitive, social and behavioural difficulties. It is suspected that children from more challenging environments e.g. low socio economic will have more difficulties in sensory integration and thus impacting negatively on development.(Jacobs and Schneider, 2001)

Sensory integration is the way the brain takes in, processes and uses the information from all the senses, to understand what is going on with our bodies and the world around us. Sensory integration in typical children develops in a developmental sequence, but some children find it more difficult to process and integrate the sensory information effectively.

Research has shown that the way that children react to the sensations around them has an impact on their behaviour and performance of daily tasks at home and at school and can result in learning difficulties.(Bundy et. al., 2002). This does not mean that there is physical brain damage, it only means that the child's neurological system is working inefficiently and that they will benefit from enriched sensory input.

Unfortunately, the identification of sensory integration difficulties in children from low socio-economic environments in South Africa are quite rare and in some areas of the country even non-existent. Occupational Therapy services within the community are largely provided by newly qualified community service occupational therapists.(Van Jaarsveld, 2010)

They have basic knowledge of sensory integration difficulties, as the use of Sensory Integration assessment and treatment requires post graduate training and knowledge and can only be provided by a therapist who has completed this specialised post graduate course.(Van der Linde, 2009) Access to an Occupational Therapist (OT) with specialised knowledge in sensory integration is therefore very limited for children from low socio economic status (SES), as according to a survey by the South African Institute for Sensory Integration 60% of these qualified Sensory Integration therapists are working in private practice.(Van der Linde, 2009) A further problem to access this service, is that the gold standard assessments, the Sensory Integration and Praxis Test (SIPT)(Ayres, 2004) is expensive and need specialised training to use and is therefore financially not viable in a community or a government setting.

In order to make these services more accessible to children from low socio-economic environments a solution for this problem could be to develop a short screening instrument for use by the community service occupational therapist in order to identify children at risk of Sensory Integration difficulties. This screening instrument will be more cost effective for use in community and government settings, more culturally appropriate and less time consuming to administer. It will not require special training on a postgraduate level, as is expected from the golden standard test (SIPT) that is available. It will therefore be more user friendly within community settings.

What do I expect from the school/centre in the study?

I would like to request permission from the schools for participation in the study.

1. The school will be ***requested to identify five to six years 11 month old children*** in grade R and grade 1 in the school, (that fall within the inclusion criteria) and to ***send out information brochures and a consent forms to the parents***, to ask for consent for their child to be included in the study.

Inclusion Criteria:

- Typical children 5 – 6 years 11 months old within in low socio-economic environments that attend the school or centre.
- Children with no obvious learning difficulty.
- All children who receive a child dependency grant, financial assistance or from a charity/service or food scheme.

Exclusion criteria:

Children diagnosed with developmental learning or behaviour problems e.g. Autism, ADHD, CP, neurological deficits, cognitive deficits, low average IQ and Epilepsy and visual and hearing impairments.

2. The child will be asked to hand the information brochures and consent forms to their parents to be signed if they are willing to participate in the study. The information brochure will make it clear to parents what the study is about, what assessments the study will include and that they will not be penalised for not participating in the study.
3. On receipt of the consent forms, ***I will send out questionnaires regarding home circumstances and background information on their child to the parents***. This will be used to determine the child's developmental milestones and their lifestyle is at home.
4. I would then like to visit the school on a pre-arranged day that suits the school in order to assess all the children with informed consent. There will be no cost involved to the school or the department.
5. I would like to return on a second occasion to assess the children using the SIPT test in order to compare the screening instrument with the gold standard test.

What do I expect from the participants in the study?

The first round of the study would consist of subjecting all children that qualify to:

1. Written parental consent and verbal child consent.
2. ***Background information*** questionnaire and ***HESSI poverty questionnaire***.
3. A short ***screening instrument*** based on sensory integration that consist of six activities n.l. putting on a T-shirt, walking heel-toe on a line, star jumps, building block patterns, clay play and cutting with scissors.

A second round of testing will consist of:

1. Repeat of the short ***screening instrument*** of sensory integration.
2. The ***SIPT test*** that consists of 17 items that require drawing, specific movements and building objects.

None of the tests will be invasive and all the activities used will be play or school related activities.

Please note: The researcher will ask the parents for permission to video the child while doing the activities. This will be used for training and quality control purposes and will not be used within the public domain. This is however not compulsory and will only be done on receiving written consent. Refusal for taking videos will not influence the participation of the child in the testing.

Are there benefits to the school/centre and participants?

Yes.

1. The screening assessment and SIPT test results will assist with making sure that the test is valid and reliable. It will be sensitive to indicate difficulties experienced by children between five to six years 11 months of age in sensory integration.
2. The findings will also assist in formulating a Sensory Integration program consisting of sensory rich activities to facilitate development in order to improve learning.
3. If any problems are identified, the parents will be informed and will be supplied with a referral letter to an Occupational therapy service within their community.
   This procedure will be followed as each Occupational Therapy department has their own referral procedures and protocols. This does however not guarantee services, as each OT service has to decide according to their own rules and policies. Unfortunately, no information regarding the individual outcome of the assessment can be given to the school without the express consent of the parents.

4. The school will also receive a generic Sensory integration program consisting of sensory rich activities to use within the school. The researcher will assist with training and implementation of this program.

What about confidentiality?

Confidentiality will be maintained by the use of a code instead of children's names on all forms, questionnaires, assessments and results. The child/parent's identity will be protected at all times and will not be published or make public at any time and the researcher will be the only person to have access to the name list and the codes used.

This list will be kept locked in an office within in a locked cabinet. The forms will be destroyed at the completion of the study.

All research assistance will be required to adhere to the rules of the HPCSA on confidentiality.

Ethical considerations

The proposal for this study went through a rigorous assessment and was approved by the postgraduate research committee, as well as the Human Research Ethics committee at the University of Witwatersrand (Permission no: **M120359)**

If you have any queries or need more information, please contact me on telephone number 0835640375 or Janine.vanderLinde@wits.ac.za. For any other questions regarding this study please contact the Human Research Ethics Committee (HREC) chairperson Prof P Cleaton-Jones on (011)7171234 or at anisa.keshav@wits.ac.za.

Please contact me if you would like to have a copy of the research protocol that will provide detailed information on the theoretical background of the study as well as on the statistical information for the study.

Thank you
Janine van der Linde
Occupational Therapist

APPENDIX M: WRITTEN CONCENT FROM SCHOOLS INVOLVED IN THE RESEARCH STUDY

Occupational Therapy

School of Therapeutic Sciences • Faculty of Health Sciences • 7 York Road, Parktown 2193, South Africa
Tel: +27 11 717-3701 • Fax: +27 11 717-3709 • E-mail: denise.franzsen@wits.ac.za

Permission Letter: Head teacher / Governing body of school

TO BE RETUNED TO:
Janine van der Linde
E-mail: Janine.vanderLinde@wits.ac.za OR
Fax Number: **086 724 1293**

I hereby **grant / do not grant** Janine van der Linde permission to conduct the study entitled:

THE DEVELOPMENT OF A SCREENING INSTRUMENT TO IDENTIFY SENSORY INTEGRATION DIFFICULTIES IN CHILDREN FROM LOW SOCIO ECONOMIC ENVIRONMENTS.

Name of School: KEOTSHEPILE PRIMARY

Address of School: MOGOLODI Street 11726
Extension7 Ikageng POTCHEFSTROOM 2531

Name of Head teacher: SMITH M.S.

Signature of Head teacher: Smit

Date: 26/09/2014

School stamp
(if applicable)

KEOTSHEPILE PRIMARY SCHOOL
P.O. BOX 40065
IKAGENG
POTCHEFSTROOM
2531
CELL: 071 495 2945
PRINCIPAL'S
SIGNATURE

For Office use only:

CODE FOR SCHOOL:
Name of school: ____________
Town school is situated in: ____________
Number of children identified: ____________

Tel: +27 11 717-3701 • Fax: +27 11 717-3709 • E-mail: denise.franzsen@wits.ac.za

Permission Letter: Head teacher / Governing body of school

TO BE RETUNED TO:
Janine van der Linde
E-mail: Janine.vanderLinde@wits.ac.za OR
Fax Number: **086 724 1293**

I hereby **grant / do not grant** Janine van der Linde permission to conduct the study entitled:

THE DEVELOPMENT OF A SCREENING INSTRUMENT TO IDENTIFY SENSORY INTEGRATION DIFFICULTIES IN CHILDREN FROM LOW SOCIO ECONOMIC ENVIRONMENTS.

Name of School: Carter Primary School

Address of School: No. 44, 4th Avenue
Alexandra, Sandton, 2090

Name of Head teacher: Ben Masupa

Signature of Head teacher: HP Masupa

Date: 2014/08/06

School stamp (if applicable)	GAUTENG DEPARTMENT OF EDUCATION Carter Primary School 2014 -08- 06 Tel: 011-443-7692 / 011-443-2689 Fax: 011-443-6635

For Office use only:

CODE FOR SCHOOL:
Name of school: ____
Town school is situated in: ____
Number of children identified: ____

Occupational Therapy
School of Therapeutic Sciences • Faculty of Health Sciences • 7 York Road, Parktown 2192, South Africa
Tel: +27 11 717-3701 • Fax: +27 11 717-3709 • E-mail: denise.franzsen@wits.ac.za

Permission Letter: Head teacher / Governing body of school

TO BE RETUNED TO:
Janine van der Linde
E-mail: Janine.vanderLinde@wits.ac.za OR
Fax Number: **086 724 1293**

I hereby **grant / ~~do not~~ grant** Janine van der Linde permission to conduct the study entitled:

THE DEVELOPMENT OF A SCREENING INSTRUMENT TO IDENTIFY SENSORY INTEGRATION DIFFICULTIES IN CHILDREN FROM LOW SOCIO ECONOMIC ENVIRONMENTS.

Name of School: FREEDOM PRIMARY SCHOOL

Address of School: 261 JAN DE NECKER DRIVE
FREEDOM PARK - DEVLAND 1811

Name of Head teacher: C.S. NDEBELE

Signature of Head teacher:

Date: 05/08/2014

School stamp
(if applicable)

GAUTENG DEPARTMENT OF EDUCATION
ISEBE LEMFUNDO E GAUTENG
UMNYANGO WEMFUNDO E GAUTENG
2014 -08- 05
FREEDOM PRIMARY SCHOOL

APPENDIX N: INFORMATION AND CONSENT LETTER TO PARENTS

Occupational Therapy

School of Therapeutic Sciences • Faculty of Health Sciences • 7 York Road, Parktown 2192, South Africa
Tel: +27 11 717-3701 • Fax: +27 11 717-3709 • E-mail: denise.franzsen@wits.ac.za

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

Janine van der Linde
Occupational therapy department
7 York Road
Parktown
2192

08/08/2014

Dear parent

I am Janine van der Linde, an Occupational Therapist at the University of the Witwatersrand in Johannesburg. I am currently completing a research project in which I am developing a screening assessment that will identify children at risk of having barriers to learning in children from five to six years old.

I would be most grateful if you would consider participating in this study by giving permission for the researcher to assess your child. The assessment will ask your child to do certain movements e.g. walk on a line, to play some block games and to colour in.

Why am I doing this?

Young children that grow up in poorer communities are at risk of developing barriers to learning, making it more difficult for them to learn, to play with friends or they may show behavioural difficulties. A solution for this problem could be to develop a short cost-effective screening assessment for use by occupational therapists to identify children with barriers to learning in the school and community.

What do I expect from the parents/participants in the study?

1. **Give written consent:** You will need to sign the consent form for the assessment and for making a video of your child and then give it back to your child's teacher.
2. I will then ask you to **fill in 2 questionnaires** that you need to send back to the teacher:
   - a questionnaire regarding your **home circumstances** and
   - a questionnaire regarding some **background** on your child.
3. An Occupational Therapist will then **come to the school to assess** your child using the screening assessment. There will be no cost involved to the school or the parents.

4. The assessment will be taped, so that we can look at it again afterwards. It will be destroyed once the study is completed. (Please tell us if you do not want us to video your child. We will then only do the assessment).

May I withdraw from the study?

Certainly you may do this at any time without having to give a reason. The study is voluntary, not taking part in it, or withdrawing from it, carries no penalty of any sort, and schooling will not be influenced.

Are there benefits to the participants?

Yes. It will assist in formulating a stimulation program for the child and school to improve learning in grade R and grade 1. The child will also be referred to Occupational Therapy services within their community.

What about confidentiality?

Confidentiality will be maintained by the use of a code instead of names on all forms, questionnaires, assessments and results. The child/parent's identity will be protected at all times and will not be published or make public at any time.

If you have any queries or need more information, please contact me on telephone number 011 717 3272 or janinevdl1@gmail.com. For any other questions regarding this study, please contact the Human Research Ethics Committee (HREC) chairperson.

Thank you

Janine van der Linde

Occupational Therapist

PLEASE CONTACT ME IF YOU NEED ASSISTANCE TO COMPLETE THE FORM.

Occupational Therapy

School of Therapeutic Sciences • Faculty of Health Sciences • 7 York Road, Parktown 2192, South Africa
Tel: +27 11 717-3701 • Fax: +27 11 717-3709 • E-mail: denise.franzsen@wits.ac.za

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

Consent form from parents

PLEASE RETURN TO:

Please fill in, sign and return to your child's class teacher

I **agree to give consent** for my child to participate in the study outlined in the information sheet.

I am aware that participation is voluntary and that there is no penalty for participation or voluntary withdrawal.

Name of the child: ____

Date of birth of child: _____________________________________

I hereby give my permission for the results of the assessment to be discussed with his/her (please tick in the space provided):

No ×	Yes ✓	*Team member*
		Teacher/School/Clinic

Permission **for video/photographs** of child to be taken (this will only be used for training purposes)

YES	NO

Name of parents: _____________________________________

Signature of parents: _________________________________

Date: ____________________

FOR OFFICE USE ONLY:

ID CODE FOR CHILD:

THERAPEUTIC Sciences

APPENDIX O: ASSENT FORM FOR CHILD

To be filled in by Occupational Therapist prior to the assessment

Agreement to participate

I have discussed the procedure with the child named: ___________________________

age: ____________ school: ____________________________and he/she has agreed to participate in the assessment.

Signature/thumbprint of the child: ____

School child attend: ____

Signature of Occupational Therapist: ____

Date: ______________________

For Office use only:

CODE FOR CHILD:

Name of child: ____

Name of school: ____

Town school is situated in: ____

APPENDIX P: BACKGROUND INFORMATION/RECORD KEEPING SHEET

Name of School: ____

Grade: ____

Research ID School/Grade/ class/number	Child's Name	DOB	Consent form	Child consent	Background Q	HESSI Q	Weight (kg)	Height/Length (cm)	BMI	Screen done	Screen data capture	SIPT	SIPT data capture	Comments/Notes

APPENDIX Q: ADAPTED HESSI QUESTIONNAIRE

Occupational Therapy

School of Therapeutic Sciences • Faculty of Health Sciences • 7 York Road, Parktown 2192, South Africa
Tel: +27 11 717-3701 • Fax: +27 11 717-3709 • E-mail: denise.franzsen@wits.ac.za

Household Economic and Social Status Index

Fill in the form or select/tick the correct block:

Child name			
Date of Birth			
Home Language	English	Afrikaans	Tswana
	Sotho	Zulu	Xhosa
	Other: ________________		
Child lives with	Both Parents	Mother	Father
	Grandmother	Grandfather	Aunt/Uncle
	Brother/Sister	Other	

I. Family Structure/Household Composition					
a. Marital Status of Mother	Never married, not now living with a partner	Married, but not living now with a partner (e.g. divorced, separated)	Widowed	Never married, but now living with partner	Married and currently living with partner
b. Household Membership. How many people currently live in the household?	Number of people living in house: __________	Number of people 18 and older: __________	Number of children 6 – 18 years old ________	Number of children under 6 yrs old _______	

II. Social Status- (Education, Occupation,)					
a. Mother's Education: What is the highest level of education attained by mother?	less than standard 3/grade 5	primary school (standard 3-4/grade 7)	junior secondary (standard 5-7/grade 9)	senior secondary (standard 8-9/grade 10/11)	Matric/ High School graduate/ vocational training diploma
	1-2 yrs College		Other training		
b. Education of Mother's Partner/Father of child: What is the highest level of education?	less than standard 3/grade 5	primary school (standard 3-4/grade 7)	junior secondary (standard 5-7/grade 9)	senior secondary (standard 8-9/grade 10/11)	Matric/ High School graduate/ vocational training diploma
	1-2 yrs College		Other training		
Access to Finances					
Who in the family earns money? Mark all that apply.	Mother	Partner/Father	Grandparent	Parent Pension	Sibling/ Aunt/ Uncle

III. Housing Accommodation					
A. In what type of housing do you live?	0. None, homeless	1. Shack	2. Hostel	3. Room, garage	4. Flat, cottage
	5. home shared with other family (ies)		6. Home that is not shared with other families		
B. Does your home have	**1. A Separate Kitchen?**	0. No		1. Yes	
	2. A Separate Bathroom?	0. No		1. Yes	
a. In your home how many separate rooms are there *just for sleeping?*	1.	2.	3.	4.	more
b. What type of toilet facilities does your home have:	0. None	1. Pit or Bucket	2. Outside flush toilet	3. inside flush	

Does the place you live in have a ....?		
a) Refrigerator	0. No	1. Yes
b) Television	0. No	1. Yes
c) Telephone	0. No	1. Yes
d) Car	0. No	1. Yes
e) Video recorder	0. No	1. Yes
f) Washing machine	0. No	1. Yes
g) Microwave oven	0. No	1. Yes

Neighbourhood Safety					
A. In general how safe is the area in which you live?	1. Extremely dangerous	2. Dangerous	3. Safe	4. Extremely safe	
B. How much do you worry about your child getting hurt when s/he is outside of your home?	1. Never	2. Sometimes	3. Often	4. All the time	

APPENDIX R: TEACHER'S QUESTIONNAIRE

Child's Name:	DOB:	GRADE:

	1	2	3	4	5	
DESCRIPTION	Finds it much more difficult than other children of the same age. Needs **much more** physical assistance and prompting than others.	Finds it more difficult than other children of the same age. Needs **more** physical assistance, more than others.	Finds it **slightly more** difficult than other children of the same age. Needs more verbal prompting than others.	The **same** as other children of the same age.	Performs **better** than other children of the same age.	**COMMENT**
Initiation of a task (start a task on own)						
Completion of tasks (finish task within required time)						
Problem solving (ability to solve a problem during a task in class)						
Organization of work (ability to organize desk, pencils, things needed for a task)						
Work speed **(complete work in required time, not too fast or too slow)**						
Follow of instructions **(follow verbal or non verbal instructions)**						
Concentration in class (can focus on the task)						
Turn taking						
Interaction with peers (interaction & play with other children)						
Fine motor skills (Scissor skills, pencil skills, colouring in, threading beads etc.)						
Gross motor skills (running, walking, catching & throwing balls)						
Balance (walking balance, running balance, sitting balance)						
Coordination (coordination of movements when doing a task)						
Manages emotions (Shows no emotions, appropriate emotions etc.)						
Behaviour (good behaviour, impulsive, tantrums, fighting a lot)						

STRENGHTS	WEAKNESS/CONCERNS

Teachers Name:

APPENDIX S: RECRUITEMENT LETTER RESEARCH ASSISTANTS

Occupational Therapy

School of Therapeutic Sciences • Faculty of Health Sciences • 7 York Road, Parktown 2192, South Africa
Tel: +27 11 717-3701 • Fax: +27 11 717-3709 • E-mail: denise.franzsen@wits.ac.za

Good day

Thank you for indicating your interest in assisting with my research project.

This letter serves as an information letter to tell you more about the project and some of the more practical issues involved.

1. Background to the problem

Cermak in Smith Roley and Schaaf(Smith Roley et. al., 2001b) p 398 states that "there is empirical evidence that availability of stimulation materials or toys, variety of stimulation, responsivity of stimuli and physical restrictiveness all influence development." Sensory experiences and the integration thereof in the nervous system aid in growth and the development of skills and when this integration is insufficient it has significant consequences on development, participation in activities of daily living and behaviour.(Bundy et. al., 2002) Literature on poverty further described that children experience delays in physical, mental and social development as a result of poverty.(Jamieson et. al., 2011) A recent report by UNICEF indicated that child poverty in South Africa is among the highest in the world with two thirds of children (approximately 58 **%**) living in poverty(3).

Unfortunately, the identification of sensory integration difficulties in children from low socio-economic environments in South Africa are quite rare and in some areas of the country even non-existent. Occupational therapy services within the community are largely provided by newly qualified community service therapists.(Van Jaarsveld, 2010) They have basic knowledge of sensory integration difficulties, as the use of sensory integration assessment and treatment requires post graduate training and knowledge and can only be provided by a therapist who has completed this specialised post graduate course.(Van der Linde, 2009) Access to an occupational therapist (OT) with specialised knowledge in sensory integration is therefore very limited for children from low socio economic status (SES), as according to a survey by the South African Institute for sensory integration 60% of these qualified sensory integration therapists are working in private practice.(Van der Linde, 2009) A further problem to access this service, is that the gold standard assessment, the Sensory Integration and Praxis Test (SIPT)(Ayres, 2004) is expensive and needs specialised training to use and is therefore financially not viable in a community or a government setting. A solution for this problem could be to develop a short cost-effective screening instrument for use by the community service therapist in order to identify children at risk of sensory integration difficulties.

A screening instrument therefore needs to be developed that not only identify the risk of sensory integration difficulties, but that also take into account the level of education and the language spoken by the community.

The results of the screening instrument will guide the community service therapist in order to determine if a child should be referred for a diagnostic test or if the implementation a sensory integration program within the community/home/school to support sensory integration.

Aim of the study

The ***aim*** of the study is to **develop a screening instrument** that consists of a short questionnaire and a short physical assessment of sensory integration. This screening instrument can be used by community service OT's or therapists within the South African context, with only basic sensory integration knowledge and not formally trained in sensory integration, to identify **children at risk of having sensory integration difficulties** in **low socio-economic communities**.

3. Screening instrument

The screening instrument was compiled following various research phases and activity analysis. Currently the instrument consists of 6 activities (dressing and undressing, heel toe walking, star jumps, construction game, play dough game and cutting activity) that the child needs to complete. This takes approximately 30-40 min depending on the level of the child. The measurement of the activities consists of observations that can be indicative of sensory integration difficulties. The therapist ticks the observation that the child is having difficulty with. The overall score on the instrument then identifies if the child is at risk of having sensory integration difficulties.

The following steps in the research project are to "test" the instrument on typically developing children from low socio-economic areas.

4. Testing typically developing children

A minimum of 200 children needs to be tested on the instrument to provide enough data for analysis. Two schools within Johannesburg (from low socio-economic areas in Soweto and Alexandra) were identified to participate in the project.

The Headmasters sent out the consent forms and each school has +/- 100 possible children for assessment (depending on consent). The assessments will be completed at the schools in a classroom that the school will make available to us.

5. Process of testing

Currently the plan is to spend at least a week at a school to assess the children from 9:00 till 13:00. The Headmasters kindly allows us to do this in school time. In this time as many children as possible needs to be tested and I will need at least 3-4 therapists to assist per day. The plan is to test children from Monday to Thursday within one school and then in another school the following week.

6. Duties of the research assistant

The research assistant will be responsible for doing the testing on the children that were Identified and that have consent to participate.

The research assistant needs to commit to participate in at least 2 assessment days (+/-9:00 – 13:00) during the assessment period. The research assistant can choose from the available times and dates that they are available to assist. Every effort will be made to accommodate assistants in the times that they are available. The reason for requesting commitment for 2 days is that it is not cost or time effective to train someone if that person is not going to commit to the process.

Positive aspects of participating in research

- Training in the use of the SI screening instrument.
- Receive a free screening kit with the articles needed to do the assessments.
- Receive CPD points from Wits for attending the training workshop and assessment sessions.
- Experience research first hand and a fun way.
- Give something back to the community.
- Be included in the list of corroborators of the published test.
- I am trying to negotiate for discount on the SAISI AGM to be held in Gauteng in 2015.

Negative aspects

- You will not receive payment for this time.
- You will need to commit at least 2 days to the assessment process.

Proposed date for workshop	23 August 2014
Proposed dates for assessments	Soweto: 25-28 August 2014 Alexandra: 1-4 September 2014

TRAINING

A training program will be made available electronically for you to work through the screening instrument in your own time.

The training program has a few quizzes or tasks that need to be completed. This just helps me to proof that you did the training and that your knowledge is up to standard.

Requested CPD points to include

- 1 Hour of Ethical lecture (2 Ethics CEU's)
- 4 Hours of Background, Administration, Observations, scoring and practical issues on SASISI screening instrument will be discussed (4 CEU's)
- Possible CEU's for assessment of child. For participation in 4 hours per day for 2 days = 8 hours. This will earn you 8 additional CEU's. (To be approved by committee)
- A total of 14 CEU's can be earned.

Please let me know if you are still interested in participating and if you will be able to do the treatment session. Also, let me know if you will need any permission letters for your work etc.

Regards

Janine van der Linde

APPENDIX T: INTERVIEW GUIDE TO DETERMINE CLINICAL UTILITY

Questionnaire Research Assistants

1. Background questions.

Where did you study	
Highest level of Education	
Years of experience in OT?	
Years of experience in Peads/SI?	
Home Language	

Do you think it is a **useful/appropriate** test for this population?

Do you think the **activities and equipment** used are appropriate for this population?

Administration of test in general: what did you find easy and what did you find difficult

What worked well?	
What aspects of the administration did you find difficult?	
What changes will you make to the format?	

What did you think about the time it took to complete the test	

Scoring in general: what did you find easy and what did you find difficult

What worked well?	
What did you find difficult?	
What changes will you make to the format?	
What will you take away/add	

General information

Manual for instrument	
Scoring sheet	
Training for using the instrument?	
Other information	

Individual tests:

	Dressing & undressing	Walking heel toe	Star jumps	Block activity	Clay activity	Spider activity
Is this a good test to do? Do you think it shows enough SI difficulties						
What worked well?						
What will you change?						
What will you add?						
What items did the children have the most difficulty with						
What items where difficult to understand by the children						

APPENDIX U: CONTENT VALIDITY QUESTIONNAIRE

DRESSING & UNDRESSING		
1. CHILD TAKES GARMENT OFF		**SCORE**
Posture during walking on line	**Postural** - Postural tone - Balance - Postural adjustments	
Initiating the walking on the line as demonstrated	**Praxis** - Ideation - Motor planning - Motor execution	
Body scheme while moving	**Discrimination** - Proprioception - Vestibular	
Postural changes while moving	**Postural** - Postural tone - Balance - Postural adjustments	
Balance & equilibrium during walking forward on line	**Postural** - Balance and equilibrium	
Use of proprioceptive input during walking on the line	**Discrimination** - Proprioception	
Knowledge of body parts e.g. where heel and toes of the foot are	**Discrimination** - Proprioception - Tactile	
Movements are in correct sequence	**BIS** - Coordinated Rhythmic Sequences of movement	
Grading of movements of body during walking	**Postural** - Body Scheme	
Use of excessive visual guidance during walking	**Discrimination** - Visual	

The sensory aspect measured (e.g. praxis) is appropriate/relevant

to the task description?

1 = not appropriate/relevant

2 = very little relation/little appropriateness

3 = some appropriateness/relevance

4 = very relevant & appropriate

Please see full document on the attached memory stick

APPENDIX V: PERMISSION FOR TRANSLATION FROM WESTERN PSYCHOLOGICAL SERVICES' (WPS)

WPS
unlocking potential

Rights & Permissions

Certificate of Limited-use License

License #:	Date:
D.A.--120413	February 3, 2015

Principal Investigator's name and title:

Janine van der Linde

Name of the Assessment:	Permitted number of uses:
Sensory Integration and Praxis Tests	150

Description of the study:

Aiming to develop a screening instrument for use with children 5 to 6 years 11 months of age, in order to empower newly qualified therapists working in these communities, to identify children at risk of having SI difficulties.

Ref: Discount Arrangements of 04Dec'13 and letter of 27Nov'13.

Method of administration:

Translation and reprint of the the instructions (only) in Zulu, Xhosa, Sotho and Tswana for reference in administration with original, WPS-published, test protocol sheets (answer sheets) for the SENSORY INTEGRATION AND PRAXIS TESTS (SIPT).

The required copyright notice that must be affixed in its entirety to each reprint/viewing of the assessment:

Instructions from the SIPT copyright © 1984, 1986,1988 by Western Psychological Services. Authorized research translation created and reprinted by J. van der Linde, University of the Witwatersrand, for specific, limited research use under license of the publisher, WPS, 625 Alaska Avenue, Torrance, California 90503, U.S.A. (rights@wpspublish.com). No additional reproduction, in whole or in part, by any medium or for any purpose, may be made without the prior, written authorization of WPS. All rights reserved.

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APPENDIX W: EXAMPLE ISIZULU TRANSLATION FROM BANGULA EDUCATIONAL SERVICES

Please see attached memory stick for full translation documents.

ZULU

1. SPACE VISUALIZATION (SV) / 1. UKUBONA INDAWO (i-SV)

For Trial 1: "Which of these blocks fits this big black hole?" If child doesn't put it in hole: "Put the block in the hole." If child chooses wrong block: "Try the other one."

Kumzamo 1: "Ngabe yimaphi amabhlokhi kulawa akwazi ukungena anele khaxa kulo mgodi omkhulu omnyama?" Uma umntwana engalifaki ibhlokhi emgodini, yithi kuye: "Beka ibhlokhi emgodini." Uma umntwana ekhetha ibhlokhi elingafanele, yithi kuye: "Zama leli elinye."

For Trial II: "Here's another. Look first; then show me which one fits ... Put it in the hole ... That's right. Think about it first; then pick up the block that fits the hole."

Kumzamo II: "Nali elinye. Qala ngokubheka kuqala; bese ungikhombisa ukuthi yiliphi elenelayo ... Libeke emgodini ... Awuboni-ke – nazo-ke! Qala ucabange ngalo kuqala; bese uthatha ibhlokhi okuyilona elenelayo emgodini."

After Item 3 or 4: "Look at BOTH blocks. Choose carefully. The first one you move counts as your choice. You want to be right the first time."

Ngemuva kwempahla 3 noma 4: "Bheka WOMABILI amabhlokhi. Khetha ngokucophelela. Ibhlokhi yokuqala ozoyinyakazisa kuzoba yiyona oyikhethile. Ngiyazi ukuthi nawe uyathanda ukuthi ukhethe okuyikhonakhona uma uqala nje ukhetha."

2. FIGURE-GROUND PERCEPTION (FG) / 2. UMQONDO WESITHOMBE ESIPHANSI (i-FG)

For Trial I: "Three of these pictures are up here. Which three are they? ... These three are not up here, are they? That is the way it will be each time I turn the page. Find three pictures down here that are up here. Look carefully because it can be tricky."

Kumzamo I: "Izithombe ezintathu kulezi zilapha phezulu. Ngabe yiziphi lezo zithombe? ... Lezi ezintathu azikho lapha phezulu, ngabe zikhona? Kuzoba njalo-ke kwisikhathi ngasinye uma ngiphendula ikhasi ngalinye. Thola izithombe ezintathu lapha ngezansi eziphezulu lapha. Bheka ngokucophelela ngokuba lokhu kungenzeka kukudide."

For Trial II: "Now you will look at designs instead of pictures of things. Three of these designs are part of this one. They are hidden in this upper design, just as some of these pictures (turn back to Plates 8A and 8B) were part of this upper figure (point to Design 1 of Plate lI B). This design is a cross, but not like the crossed lines up here, so it is not part of the upper design. This one (Design 2) is part of the design up here. Can you see it? Can you see this one (Design 3) up here? Some of the lines in this upper picture are not always in the choices down here. Which of these (Designs 4, 5, and 6) is hidden in this design? ... The rest of the designs will be something like this one. Find the three designs here that are up here."

Kumzamo II: "Njengamanje uzobheka imiklamo eyenziwe esikhundleni sezithombe sezinto. Imiklamo emithathu kulena iyingxenye yalo mklamo. Ngamanye amazwi ifihlwe kulo mklamo ophezulu, njengezinye zalezi zithombe (buyela emuva Kumapuleti 8A kanye no 8B) zibe yingxenye yalesi sithombe esiphezulu (khomba Umklamo 1 Wepuleti lI B). Lo mklamo uyisiphambano, kodwa awufani nemigqa ephambene lapha ngenhla, nokusho ukuthi ngamanye amazwi lo mklamo awusiyona ingxenye yomklamo ophezulu. Kodwa lo mklamo (Umklamo 2) uyingxenye yomklamo lapha phezulu. Ngabe uyawubona na? Ngabe uyawubona yini lo mklamo (Umklamo 3) lapha phezulu? Eminye imigqa kulesi sithombe esiphezulu ayivamile ukuba kule ndawo ephansi njalo lapha. Ngabe yimiphi imiklamo kulena (Imiklamo 4, 5, kanye no 6) efihlwe kulo mklamo? ... Imiklamo yonkana izoba yinto ezobukeka kanje njengalona. Thola imiklamo emithathu lapha phezulu ngokwakho."

APPENDIX X: POWER POINT TRANSLATIONS OF AFRICAN LANGUAGES

Please see attached memory stick for full power point presentations

ZULU

1. SPACE VISUALIZATION (SV) / 1. UKUBONA INDAWO (i-SV)

1. SPACE VISUALIZATION (SV) / 1. UKUBONA INDAWO (i-SV)

For Trial 1:

"Which of these blocks fits this big black hole?"

"Ngabe yimaphi amabhlokhi kulawa akwazi ukungena anele khaxa kulo mgodi omkhulu omnyama?"

If child doesn't put it in hole:

"Put the block in the hole."

"Beka ibhlokhi emgodini."

If child chooses wrong block:

"Try the other one."

"Zama leli elinye."

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<u>1. SPACE VISUALIZATION (SV) / 1. UKUBONA INDAWO (i-SV)</u> Trial II:

For Trial II:

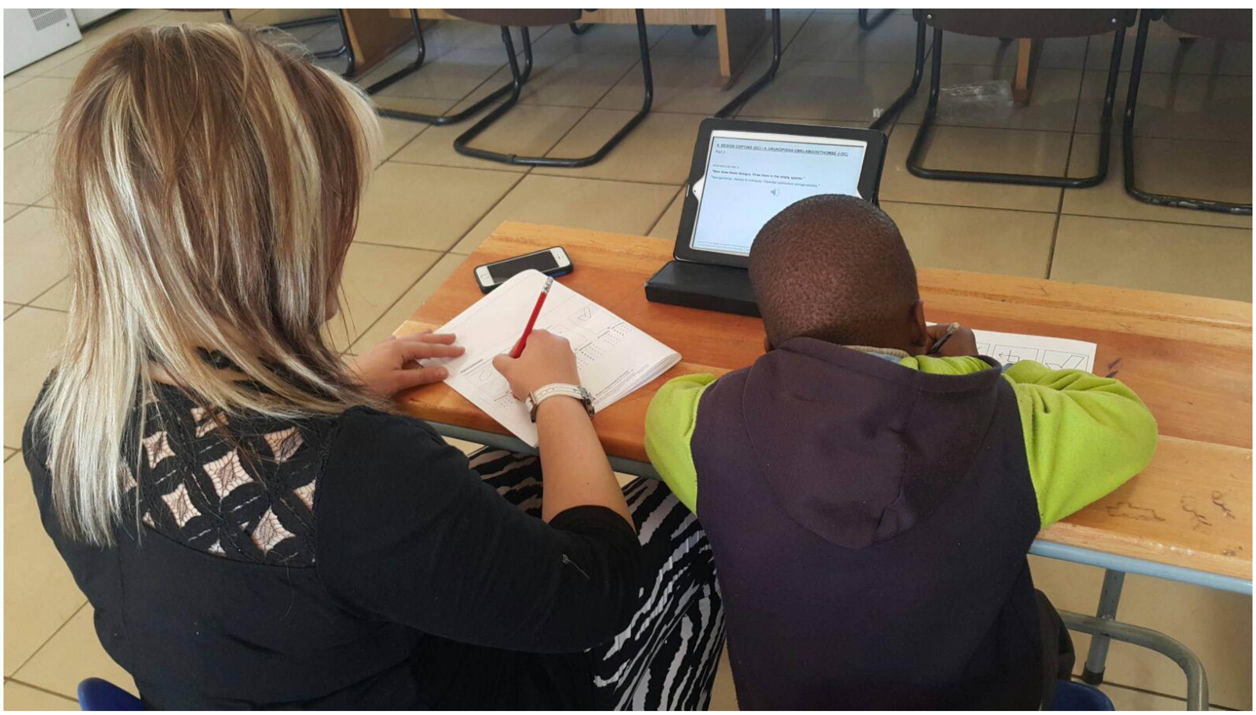
"Here's another. Look first; then show me which one fits ... Put it in the hole."

"Nali elinye. Qala ngokubheka kuqala; bese ungikhombisa ukuthi yiliphi elenelayo ...

Libeke emgodini."

"That's right. Think about it first; then pick up the block that fits the hole."

"Awuboni-ke – nazo-ke! Qala ucabange ngalo kuqala; bese uthatha ibhlokhi okuyilona elenelayo emgodini."



APPENDIX Y: REFINED VERSION OF THE SASISI MANUAL

Please see attached memory stick for full refined manual

SASISI

THE SOUTH AFRICAN SENSORY INTEGRATION SCREENING INSTRUMENT

INTRODUCTION

The South African Sensory Integration Screening Instrument (SASISI)

PURPOSE OF TEST:

The ***aim*** of the screening assessment is to identify **children at risk of having sensory integration difficulties** that lives up in **low socio-economic communities**.

RATIONALE FOR DEVELOPMENT OF TEST

Cermak (2001a: 398) states that “there is empirical evidence that availability of stimulation materials or toys, variety of stimulation, responsivity of stimuli and physical restrictiveness all influence development”. Sensory experiences and the integration thereof in the nervous system supports growth as well as the development of occupational performance skills and when integration is insufficient it has significant consequences on development, participation in activities of daily living and behaviour (Bundy et. al., 2002).

It is suspected that children from more challenging environments e.g. low socio-economic or from institutionalized environments, will have more challenges regarding sensory integration and thus impacting development (Jacobs and Schneider, 2001). According to Jacobs and Schneider the environment is an important contributor to the information received through the sensory systems during childhood and the functioning of the nervous system reflects interaction between biological and environmental influences (Jacobs and Schneider, 2001). Environmental deprivation could lead to various challenges such as malnutrition, stunted growth, behaviour problems, developmental delay, and the ability to learn and to play (Bradley and Corwyn, 2002). Research in Romanian children who resided in institutions indicated that these children may be at risk for the development of sensory integration difficulties (Smith Roley et. al., 2001b; Lin et. al., 2005). The researchers found two risk factors namely environmental deprivation and lack of a significant person that played a role in poor developmental skills.

South Africa is a country with a very high unemployment rate (25%), where 58% of the children are reported to be living below the poverty line and poor socio economic circumstances are frequently encountered (Berry et. al., 2013). Although studies have been done on sensory integration functions and institutionalised environments, very limited research results are available thus far on the influence of low socio-economic status (SES) on sensory integration functions, especially in South Africa (Smith Roley et. al., 2001b; Bundy et. al., 2002; Van Jaarsveld et. al., 2001b).

Few studies in South Africa have examined the prevalence of sensory integration difficulties in low socio- economic environments. A study was done by Van Jaarsveld et. al. (2001b) who found that there is a high prevalence of sensory integration difficulties in children from a low socio-economic settings (Van Jaarsveld et. al., 2001b).

In four small studies done by students from the University of the Free State it was further found that there is a statistical significant difference between children from high and low socio-economic areas with regards to sensory integration difficulties (Van Jaarsveld, 2010).
Unfortunately, the identification of sensory integration difficulties in children from low socio-economic environments in South Africa are quite rare and in some areas of the country even non-existent. Occupational therapy services within the community are largely provided by newly qualified community service examiners (Van Jaarsveld, 2010). If included in their undergraduate training they may have basic knowledge of sensory integration difficulties, as the use of sensory integration assessment and treatment requires post graduate training and specialised sensory integration services can only be provided by an examiner who has completed specialised post graduate courses (Van der Linde, 2009). Access to an occupational examiner (OT) with specialised knowledge in sensory integration is therefore very limited for children from low socio-economic status (SES), as according to a survey by the South African Institute for Sensory Integration (SAISI) 60% of these qualified sensory integration examiners are working in private practice (Van der Linde, 2009).

A further problem to access this service, is that the gold standard assessment for sensory integration dysfunctions, the Sensory Integration and Praxis Tests (SIPT) (Ayres, 2004) is expensive and needs specialised training to use and is therefore financially not viable in a community or a government setting. It is therefore important to equip community service OTs to be able to identify children at risk of having sensory processing and integration difficulties.

The activities included in this assessment tool were chosen by a panel of SA occupational examiners that are SI qualified and knowledgeable in regard to sensory integration. The activities that were included in the research for this assessment tool had to adhere to specific criteria and needed to be a functional occupational performance activity. Each activity was analysed using the key aspects of sensory integration and the Model for Clinical reasoning by Annamarie van Jaarsveld (Van Jaarsveld, 2011).

This screening instrument needs to be done in conjunction with the Ayres clinical observations and a parent interview or the completion of a background questionnaire.

AGE RANGE:

The screening instrument is for use with children from 5 years 0 months to 6 years 11 months. This is the age in which most of the children in South Africa access formal schooling.

This age group was chosen for the following reasons:

- ❖ It will be beneficial to identify problems earlier in the school environment in order to arrange for intervention
- ❖ According to a pilot study done at a hospital in the North west province, 70,3 % of the children referred for services where between five years and six years 11 months (Van der Linde, 2009).
- ❖ This is traditionally the age group where children attend school for the first time in South Africa and are identified as having difficulties and are then referred for occupational therapy intervention
- ❖ The age range for using the SIPT test (the gold standard test) is within 4.0 years – 8.11 years of age (Ayres, 2004).

DESCRIPTION OF TEST:

The screening instrument is an activity-based instrument that includes a parent/caregiver questionnaire and an observational scale of children engaged in activities performed in typical occupational performance areas relevant for children of the age range 5 years 0 months to 6 years 11 months.

Occupational performance areas such as play, activities of daily living, school related tasks and motor tasks are represented by the following activities:

- ❖ **Activities of daily living**: Dressing and undressing of T-shirt
- ❖ **Motor related activities**: Walking heel toe and performing star jumps.
- ❖ **Play activities**: Building block games & Clay games
- ❖ **School related activities:** Cutting with scissors activity
- ❖ **Type of instrument**: Developmental screening instrument

APPENDIX Z: REFINED SCORING SHEET

Please see attached memory stick for full refined manual

DRESSING & UNDRESSING							
STEPS OF ACTIVITY	AREA MEASURED	OBSERVATIONS THAT COULD BE AN INDICATION OF DIFFICULTIES (Indicate with ✓ which area difficulties were experienced in)	[illegible]	[illegible]	[illegible]	[illegible]	COMMENTS (Indicate with ✓ which area difficulties were experienced in)
1. CHILD TAKES GARMENT OFF							
The child knows how to start and execute the task of taking of the garment	Praxis - Ideation - Motor execution	* Difficulty in knowing/figure out what his/her body needs to do in order to move to start the task * Clumsy in starting the activity * Slow to start and finish task	1	2	3	4	Accuracy ☐ Control ☐ Quality ☐ Avoidance ☐
Grip of T-shirt/garment with hands	Object Manipulation - Grasp - Type	* Able to take hold of garment within his/her hand without it slipping out of the hand * Able to let go of garment in order to move to the next step	1	2	3	4	Accuracy ☐ Control ☐ Quality ☐ Avoidance ☐
Quality of control of body movements	Postural - Postural tone - Balance - Postural Adjustment	* Fixates body in order to maintain balance during task * Needs to hang onto furniture to keep upright during the task * Poor lateral flexion and trunk rotation when taking garment off * Excessive moving around when taking garment off	1	2	3	4	Accuracy ☐ Control ☐ Quality ☐ Avoidance ☐
Quality of control of execution of body movements	Praxis - Motor execution	* Poor quality of movements * Easily frustrated with execution of task * Poor coordination in execution	1	2	3	4	Accuracy ☐ Control ☐ Quality ☐ Avoidance ☐
Motor execution of the task accurate and smooth	Praxis - Motor execution	* Smoothness of movements during the execution of task poor	1	2	3	4	Accuracy ☐ Control ☐ Quality ☐ Avoidance ☐
Speed of movement	Postural - Postural tone - Righting & equilibrium	* Too slow or too fast in movement of taking garment off * Impulsive movements influences balance	1	2	3	4	Accuracy ☐ Control ☐ Quality ☐ Avoidance ☐
Speed of execution of movement	Praxis - Motor execution	* Slow to finish tasks * Disorganized in doing th task * Poor flow of movement	1	2	3	4	Accuracy ☐ Control ☐ Quality ☐ Avoidance ☐
Sequence of steps of getting undressed	BIS - Sequences of movements	* Poor coordination of 2 sides of body during dressing sequence * Struggle to know which steps follow next in sequence	1	2	3	4	Accuracy ☐ Control ☐ Quality ☐ Avoidance ☐
Sequence of steps of getting undressed	Praxis - Ideation - Motor planning	* Unable to plan where to start with the task and to continue without assistance * Asking for assistance * Difficulty in doing the task	1	2	3	4	Accuracy ☐ Control ☐ Quality ☐ Avoidance ☐
2. CHILD PUT GARMENT ON							
The child knows how to start and execute the task of taking of the garment	Praxis - Ideation - Motor execution	* Disorganized in approach to task * Unsure how to start the task * Clumsy in starting the activity	1	2	3	4	Accuracy ☐ Control ☐ Quality ☐ Avoidance ☐
Grip of T-shirt/garment with hands	Object Manipulation - Grasp - Type	* Able to take hold of garment within his/her hand without it slipping out of the hand * Able to let go of garment in order to move to the next step	1	2	3	4	Accuracy ☐ Control ☐ Quality ☐ Avoidance ☐
Speed of execution of movement	Praxis - Ideation - Motor execution	* Slow to finish tasks * Disorganized in doing the task * Poor flow of movement	1	2	3	4	Accuracy ☐ Control ☐ Quality ☐ Avoidance ☐
Control of arm movements	Praxis - Motor execution	* Uncoordinated movements with arms * Unable to elevate arms for taking of garment * Struggle to control movements	1	2	3	4	Accuracy ☐ Control ☐ Quality ☐ Avoidance ☐
3. GENERAL OBSERVATIONS							
Postural while doing the activity	Postural - Postural tone - Postural stability	* Unable to keep self upright while dressing * Observed signs poor muscle tone: Winged scapulae, Lordosis, Protruding belly * Complains of getting tired easily * Unable to sustain posture to generate muscle tone * Constantly on the move	1	2	3	4	Accuracy ☐ Control ☐ Quality ☐ Avoidance ☐
Shoulder stability while doing the activity	Postural - Postural tone - Postural stability	* Winging scapulae * Arms and shoulders tire easily	1	2	3	4	Accuracy ☐ Control ☐ Quality ☐ Avoidance ☐
Orientating T-shirt so that it faces the correct way to put it on again	Visual Form & Space - Spatial perception	* Able to turn garment around so that seams of garment are inside of garment	1	2	3	4	Accuracy ☐ Control ☐ Quality ☐ Avoidance ☐
Ensure the front of t-shirt is at the front, with the label of the T-shirt at the back * Spatial perception of front and back of T shirt	Visual Form & Space - Spatial perception	* Able to turn garment around so that the front of garment faces toward the front of the body	1	2	3	4	Accuracy ☐ Control ☐ Quality ☐ Avoidance ☐
Put T-shirt on with label at the back	Visual Form & Space - Spatial perception	* Able to turn garment around so that the label is at the back of the child's neck	1	2	3	4	Accuracy ☐ Control ☐ Quality ☐ Avoidance ☐
Opening & closing buttons/zips/laces	Object Manipulation - Grasp - Type	* Able to take hold of garment within his/her hand without it slipping out of the hand * Able to let go of garment in order to move to the next step	1	2	3	4	Accuracy ☐ Control ☐ Quality ☐ Avoidance ☐

APPENDIX AA: TURNITIN REPORT

FINAL PHD VERSION

ORIGINALITY REPORT

6%	3%	3%	2%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Asia Pacific University College of Technology and Innovation (UCTI) Student Paper	<1%
2	Submitted to Higher Education Commission Pakistan Student Paper	<1%
3	Submitted to University of Ulster Student Paper	<1%
4	Meyer, Katharina, Andreas Klipstein, Peter Oesch, Beatrice Jansen, Jan Kool, and Karin Niedermann. "Development and Validation of a Pain Behavior Assessment in Patients with Chronic Low Back Pain", Journal of Occupational Rehabilitation, 2015. Publication	<1%
5	Sibylle Heilbrunn, Tamar Almor. "Is entrepreneurship education reproducing social inequalities among adolescents? Some empirical evidence from Israel", The International Journal of Management	<1%