ENVIRONMENTAL FACTORS, SENSORY MODULATION AND DEVELOPMENT OF PRETERM INFANTS IN THE NEONATAL HIGH CARE UNIT

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A dissertation submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Master of Science in Occupational Therapy

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Declaration

I, Nicole Paul hereby declare that this dissertation is my own work. It is being submitted for the degree of Masters of Science in Occupational Therapy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other university.

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Dedication

To my Husband, thank you for your patience, understanding and guidance during this process, and for "taking one for the team" – I love you.

My Family especially my Pops, Mom, Sister and Brother, thank you for giving me the strength to be able to complete this research, through thick and thin we will always stand together – I love you.

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Abstract

This study aimed to determine the association between preterm infant demographics and their sensory modulation; and to describe a link between the Neonatal High Care Unit (NHCU) environmental factors, sensory modulation and development of premature infants born in Edenvale General Hospital. The NHCU was assessed using the Implementation of Neurodevelopmental Supportive Care (INDeSC) checklist and 48 observations were conducted over a period of six-months. Twenty-two preterm infants participated in the study. Sensory modulation for the infants was determined using the Infant Sensory Profile™ 2 (ISP 2) at 4 weeks post discharge and again at 3-6 months (corrected age). The Bayley Scales of Infant Development – 3rd Edition® (Bayley-III) was used to determine their developmental age.

The INDeSC checklist indicated most criteria, suggested to simulate a uterine-like environment, which was not adhered to in the NHCU. This may have influenced the infants' sensory modulation. At 4 weeks post discharge, just under sixty percent of the infants presented with sensory modulation difficulties (SMD) related to over responsivity. No trend could be found for the scores on the ISP 2 and the Bayley-lll, when the scores for each infant were compared at age 3-6 months (corrected age). All the infants, who returned, however, presented with a risk for SMD as well as developmental delay.

This study highlights the importance of on-going monitoring of the development and sensory modulation of infants who are born prematurely. The lack of adherence to criteria for simulating a uterine-like environment within the NHCU/NICU can further affect early development.

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Operational Definitions

Bayley Scales of Infant and Toddler Development - III®: An assessment tool developed by Nancy Bayley to measure, identify and assess development in children. It is a comprehensive method of identifying developmental issues or delays in children from the ages of one month to 42 months, to assist healthcare professionals in early detection and to ensure early intervention is carried out (Bayley, 2007).

Dysregulation: Impairment in the regulation of a metabolic, physiological, or psychological process in the brain, resulting in dysfunction (Ayres, 1979; Case-Smith & O'Brien, 2013).

Neurodevelopmental Supportive Care: This approach refers to strategies used in the neonatal intensive care unit (NICU) or the Neonatal High Care Unit (NHCU) to decrease the stress on preterm infants by simulating a uterine-like environment (Lubbe, 2009).

Neonatal Intensive Care Unit (NICU): A unit for infants who need mechanical ventilation, total parenteral nutrition, who have a complex problem requiring further investigation and management, or who have a neonatal surgical problem. It is advanced care for very small and immature infants or those whose long-term outcome may be poor (Robertson, et al., 2013). This is a specialised hospital nursery facility designed for infants with critical care needs (Case-Smith & O'Brien, 2013; Lubbe, 2008).

Neonatal High Care Unit (NHCU): A unit for the care of ill infants, including infants who require cardio-respiratory monitoring, oxygen therapy of more than 40%, nasal prong CPAP, those who have recurrent apnoea and convulsions, or who may need an exchange transfusion (Robertson, et al., 2013).

Praxis: The ability to conceptualise, plan and execute novel motor actions. Praxis is being able to organise a sequence of events and direct motor actions. Praxis allows for the adaption and quick reaction in a meaningful manner within new environmental demands (May-Benson, et al., 2009; Williamson & Anzalone, 2001).

Sensory-based motor disorder: This encompasses a motor challenge with an underlying sensory basis, which consists of two disorders – postural disorder and dyspraxia (Collins & Miller, 2012).

Sensory discrimination: The ability to distinguish and understand the difference between spatial and temporal qualities of sensory information (May-Benson, et al., 2009).

Sensory discrimination disorder: Is the inability to interpret information that allows a person to compare various details, thus being unable to disregard irrelevant information (Miller & Collins, 2012).

Sensory integration: "It is the neurological process that organises sensation from the body and environment and enables us to use our body effectively within the environment" (Wickremasinghe, et al., 2013, p. 11).

Sensory modulation: An individual's ability to respond adaptively to sensation over a broad range of intensity and duration (Lubbe, 2009).The individual therefore needs the ability to regulate the intensity, degree and nature of sensory stimuli and have the capacity to process sensory information in order to generate responses that are appropriately graded in relation to the incoming sensations (Holmes, et al., 1982; Lombard, 2007; Wickremasinghe, et al., 2013).

Sensory modulation disorder or dysfunction: A specific pattern of dysfunction of sensory integration, where a person under or over responds to sensory input from the environment or their own body (May-Benson, et al., 2009).

Sensory processing: "Functions related to sensation occurring in the central nervous system, including reception, modulation, integration, and organization of sensory stimuli; also includes the behavioural responses to sensory input" (Bundy, et al., 2002, p. 480).

Abbreviations

ASI®	Ayres Sensory Integration®
Bayley-III	Bayley Scale of Infant Development – 3rd Edition®
CNS	Central Nervous System
dB	Decibels
DSM	Diagnostic and Statistical Manual of Mental Disorders
EC	Expressive Communication (EC)
GAC	General Adaptive Composite
INDeSC	Implementation of Neurodevelopmental Supportive Care Checklist
LPI	Late Preterm Infants
ISP 2	Infant Sensory Profile™ 2
KMC	Kangaroo Mother Care
LBW	Low Birth Weight
NDSC	Neurodevelopmental Supportive Care
NHCU	Neonatal High Care Unit
NICU	Neonatal Intensive Care Unit
PIPP	Premature Infant Pain Profile
Preterm infant	Premature infant
RC	Receptive Communication

TSFI	Test of Sensory Functions in Infants™
SBMD	Sensory-Based Motor Disorder
SD	Standard Deviation
SDD	Sensory Discrimination Disorder
SPD	Sensory Processing Disorder
SMD	Sensory Modulation Disorder
SP	Sensory Profile
SSP	Short Sensory Profile
WHO	World Health Organization

CHAPTER 1: INTRODUCTION

1.1 Introduction

The sensory developmental process is multifaceted and starts in utero. A newborn infant learns to register and modulate sensory stimuli within their protected environment (May-Benson, et al., 2009). This allows them to be able to respond appropriately, behaviourally and emotionally to changes in the environment (Shenai & Bijlani, 2010). Sensory development facilitates the materialisation of occupational engagement and social participation, and as the process progresses, the infant begins to attach meaning to the diverse sensory experiences (Case-Smith & O'Brien, 2013).

Sensory modulation is the process by which the infant regulates sensory inputs and organises different reactions to the sensory information registered by the infant's sensory system (Bundy, et al., 2002). Thus, the infant learns to adapt their behaviour and control their reactions in relation to the sensory input (Harcourt Assessment Inc, 2005), using either, inhibitory and excitatory responses (Bundy, et al., 2002).

Premature infants experience challenges in their sensory development as they are removed from the uterus that provides support, protection and is the optimal environment to develop sensory processes. These infants' in utero development is therefore not complete (Lubbe, 2008). Premature infants admitted to Neonatal Intensive Care Unit (NICU) and Neonatal High Care Unit (NHCU), are surrounded by sophisticated technology, which is required to keep them alive (Case-Smith, et al., 1998). This technology, which includes bright lights and potentially noisy environments, is thought to result in stress reactions and sensory overstimulation in these infants (Lubbe, 2008) (Nair, et al., 2003), which may alter their sensory system function and development (Nair, et al., 2003). Research has linked this overstimulation to sensory processing dysfunction or deficits (May-Benson, et al., 2009; Case-Smith, et al., 1998; Nair, et al., 2003).

These sensory processing deficits can result in a sensory processing disorder (SPD). Sensory processing disorder can be divided into three types: sensory modulation disorder (SMD), sensory discrimination disorder (SDD) and sensory-based motor disorder (SBMD). Sensory modulation disorder (SMD) can present as a dysfunction in the ability to modulate sensory input from the environment. Sensory discrimination disorder is where the demands of the environment result in an inappropriate emotional or attentional response from the individual, while sensory-based motor disorder (SBMD) presents with involuntary movement and postural dysfunction when sensory input is processed incorrectly. Dysfunction in sensory processing can result in developmental delay, affecting participation in all occupational performance areas such as play, self-care, sleep, socialisation and schooling as the infant develops (Miller, et al., 2007). In this particular study, the researcher will focus mainly on sensory modulation.

1.2 Problem Statement

While research on the NICU/NHCU environment has been done in South Africa, some concerns have been raised regarding the environmental factors not being uterine-like for optimal development for a preterm infant (Lubbe, 2009; Robertson, et al., 2013), coupled with a limited amount of data on the link between demographic and possible sensory overload related to NICU/NHCU environmental factors and the sensory processing dysfunction and developmental delay (Mitchell, et al., 2015; Wickremasinghe, et al., 2013) in preterm infants (Harcourt Assessment Inc, 2005) in this country. There is limited information available on the prevalence and the patterns of sensory processing dysfunction in preterm infants, particularly in relation to the NICU and the NHCU environment in South Africa (Mitchell, et al., 2015). Research has been done on the delays and deficits preterm infants struggle with in general, however, there is a missing link in the research regarding the effect of the environment on the sensory development as a whole. Infants, specifically preterm infants, are often referred to occupational therapists much later and it might be possible to prevent the delayed referrals, should this research uncover important information regarding the effect of the environment on the preterm infants.

1.3 Purpose of the study

There is a paucity in the research concerning premature infants, who have had a prolonged stay in the NHCU and possible sensory modulation dysfunction related to this. This study will provide information on the demographic and NHCU environmental factors possibly linked with dysfunction in sensory processing and developmental delay in preterm infants, so these can be addressed or recognised for early intervention.

1.4 Research question

Is there a link between demographic and NHCU environmental factors, the sensory modulation and development of the preterm infant?

1.5 Aim

To determine the association between preterm infant demographics and their sensory modulation and to describe a possible link between the NHCU environmental factors, sensory modulation and the development of preterm infants.

1.6 Objectives

The study had 2 phases:

PHASE 1

Objective 1: To determine demographics of preterm infants and NHCU environmental factors, at the time the infants are in the NHCU.

Objective 2: To determine sensory modulation using the Infant Sensory Profile™ 2 (ISP 2) of preterm infants at age 4 weeks post discharge.

Objective 3: To describe the preterm infants' sensory modulation and the frequency of adherence to neurodevelopmental supportive care criteria in the NHCU environment and the possible link between them.

PHASE 2

Objective 4: To determine the sensory modulation using the Infant Sensory Profile™ 2 (ISP 2) of preterm infants at age 3-6 months (corrected age).

Objective 5: To compare the 4-week sensory profile of the preterm infants who returned and those who did not return at 3-6 months (corrected age).

Objective 6: To determine the developmental level of the preterm infants at age 3-6 months using the Bayley Scale of Infant Development – 3rd Edition ® (Bayley-III).

Objective 7: To describe the sensory modulation of preterm infants at age 3-6 months (corrected age) and their developmental level using the Bayley Scale of Infant Development – 3rd Edition ® (Bayley-III).

1.7 Justification for the study

This research project aims to broaden the knowledge base of sensory integration, as well as determine if a link exists between demographic and NHCU environmental factors and later sensory modulation and developmental function of the preterm infant.

Bröring et al., in their systematic review in 2017, discuss how neurodevelopmental sequelae in preterm infants is commonly considered to result after cerebral white matter damage of the brain and harmful effects of environmental factors in the neonatal Intensive Care Unit (NICU). Sensory processing difficulties with regards to registration, integration and modulation, may be due to cerebral white matter damage. However, research into sensory processing difficulties and, in particular, sensory modulation difficulties, is scarce in preterm infants in general (Bröring, et al., 2017).

Premature infants experience difficulties in modulation with regards to vestibular, proprioceptive, tactile, auditory, visual, gustatory and olfactory processing problems depending on the degree of prematurity (Lubbe, 2008). This study should provide information for occupational therapists about sensory modulation difficulties that may result from prematurity and an extended stay in the NICU/NHCU.

Occupational therapists, working as part of a multidisciplinary team, have comprehensive abilities, and a unique perspective including the experience needed to assist and treat newborn infants and premature infants in their quest to progress developmentally. Research shows that preterm infants who receive developmental treatment in the NICU demonstrate better developmental results in the long-run

(Holmes, et al., 1982). These infants tend to thrive in the NICU. Improvement and progress of preterm infants can enable an earlier discharge from the hospital, thus identifying these infants would be beneficial for therapists. Prematurity is known to influence the normal progression of child development, therefore occupational therapy intervention is of great importance (Rabinovich, et al., 2015).

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This literature review serves to describe normal foetal development, prematurity, sensory systems linked to problems and function related to prematurity and the NICU/NHCU. Sensory integration and modulation, the impact that demographic and environmental factors have on prematurity and sensory integration, are also reviewed.

2.2 Normal Foetal Development

In a full-term pregnancy, the foetus has approximately 40 weeks to develop. Once each week has passed, the weeks are grouped together and referred to as the gestation period (Lubbe, 2008; Faure, et al., 2016; Moore, et al., 2018). These 40 weeks are broken down into three trimesters. The first trimester begins at conception and ends at 12 weeks gestation, the second trimester starts at 13 weeks and ends at 27 weeks, and the third trimester starts at 28 weeks and ends at 40 weeks. An unborn baby is classified as an embryo up until eight weeks from fertilisation, which is at 10 weeks gestation, and then classified as a foetus. In the first trimester, brain and motor development start to occur and by the second week of pregnancy, nervous system pathways have already started to develop (Lubbe, 2008; Moore, et al., 2018). By the end of the second trimester, the heart of the foetus has started to beat rhythmically and is controlled by the brain (Lubbe, 2008). Each trimester is important because in each, so many different sensory systems develop (Faure, et al., 2016).

Research is becoming more readily available with regard to the functioning of foetal sensory systems during gestation (Lecanuet & Schaal, 1996). Lecanuet and Schaal discuss the presence of potential sensory stimulation in the foetal environment and the consecutive functional development of the sensory systems, physiological and behavioural responses of foetuses to various types of stimulation. Many studies have investigated auditory, olfactory and gustatory responsiveness of the foetus in the second half of gestation (Jensen, 1984; Tanaka & Arayama, 1969; Sontag & Wallace, 1935; Wedenburg, 1965), and reported that motor and heart rate depend on gestational age and that foetal sensory experience has short- and long-term effects at morphological, functional and behavioural levels (Lecanuet & Schaal, 1996). Infants are intended to be carried to full term gestation between 37 and 42 weeks (Lubbe, 2008), and those born before 37 weeks are considered premature.

2.3 Prematurity

The WHO classifies prematurity into extremely premature (< 28 weeks), very premature (28 to <32 weeks) and moderate to late prematurity (32 to < 37 weeks) (World Health Organization, 2018). An estimated 15 million babies are born prematurely every year, and this is the leading cause of mortality in children under the age of 5 years old (World Health Organization, 2018).

There are many possible causes for prematurity, including infections, allergens, endocrinologic phenomena, environmental toxins and nutritional parameters, as well as sexual activity (Darrow, et al., 2009). Maternal risk demographics related to prematurity include the mothers' age (being under 16 or over the age of 40), mothers' use of drugs or alcohol exposure during pregnancy, and mothers having diabetes, hypertension, bleeding during the pregnancy and sexually transmitted diseases. Multiple pregnancies and premature rupture of membranes in the womb are also associated with early birth, as are foetal distress/birth asphyxia during labour, breech delivery, meconium, nuchal cord and forceps or caesarean delivery. Infant demographics that focus on or that contribute to premature births include: birth defects, respiratory distress, infection such as herpes, group B streptococcus, seizures, hypoglycaemia, need for extra oxygen and or blood transfusions (Lubbe, 2008).

Although medicine and technology have advanced, the rate of prematurity has not decreased (Thomas & Bailit, 2016). While statistics show 10% of infants in the United States are born prematurely (Center for Disease Control and Prevention, 2016), in South Africa the reported incidence is 15% due to poor antenatal care and poor attendance during pregnancy at clinics and hospitals (Fouché, et al., 2018; Lubbe, 2008).

Prematurity comes with an increased risk, immediate medical complications, as well as social-emotional, cognitive, language, and sensory processing problems later in life. Studies have explored the effects of prematurity on developmental outcomes, such as cognition (Nosarti, et al., 2008; Wickremasinghe, et al., 2013). The increased risks of developmental and cognitive delays have also been associated with difficulties with mother-infant relationships and these children are prone to learning disabilities (World Health Organization, 2018).

Delays and changes in the sensory system can affect normal development and behaviour, as according to Ayres' Theory of Sensory Integration the organisation of the sensation from the body and environment, allows the use of the body effectively within the environment (Bundy, et al., 2002). Thus, dysfunction in sensory systems affects behaviour states due to the loss of the in-utero environment before certain neural maturation occurs (Machado, et al., 2017).

2.3.1 Sensory Integration

In occupational therapy, understanding of the integration of the sensory systems and the process by which sensation is registered, modulated, and discriminated through the sensory systems to produce purposeful, adaptive behaviours in response to the environment, is important. The enactment of appropriate behaviours results in learning, which supports normal development and participation in occupations (Botha, 2015; Bundy, et al., 2002).

Ayres regarded the sensory integrative behavioural process and reported on three major hypotheses.

- Firstly, learning is dependent on a person's ability to register or take in and process sensations from movement as well as the environment, and to use it in order to plan and organise behaviour
- Secondly, learning and behaviour may be problematic for individuals who experience difficulty in producing appropriate actions relating to a decreased ability to process sensory information
- Lastly, learning and behaviour can be improved by a modulated sensation, as part of a meaningful activity that aids in an adaptive interaction (Bundy, et al., 2002)

There is little consensus regarding the use of terminology in the field of sensory integration when describing dysfunction with both Sensory Integrative Dysfunction

(SID) (Schaaf, et al., 2009) and Sensory Processing Disorder (SPD) being used (Miller, et al., 2007). Sensory processing disorder, however, describes the entire central and peripheral nervous system resulting in difficulties in processing and using sensory information for the regulation of motor, affective, physiological and attention responses. This includes dysfunction in the reception, modulation, integration and organisation of sensory stimuli, affecting the behavioural response to the sensory input and affecting participation in activities of daily living (Machado, et al., 2017). Miller describes three types of sensory processing disorder: sensory-based motor disorders (SBMD), sensory discrimination disorder (SDD) and sensory modulation disorder (SMD). This study considers dysfunction in sensory modulation disorder in premature infants since literature indicates a stay in the NICU may affect sensory modulation resulting in sensory over-responsivity or possibly sensory under-responsivity (Miller, et al., 2007). To appreciate the effects of SMD, it is important to understand the development during gestation. This study therefore considers dysfunction in sensory processing and in particular, the subtype of sensory modulation disorder (SMD) (Miller, et al., 2007) in premature infants.

2.4 Development of sensory systems during gestation and effect of dysfunction

When considering sensory processing problems, the normal development of the sensory systems and the factors that can influence the normal development of the infant and child must be considered. Development of the sensory systems begin in utero, with each sensory system developing within its own period. The sensory sytems include the tactile, vestibuler, proprioceptive, gustatory, olfactory, auditory and visual systems.

2.4.1. The Sensory system

2.4.1.1 Tactile System

In the eighth week of gestation, the embryo’s tactile system starts to develop, and at 10½ weeks, the foetus has feeling in the palms of its hands (Faure, et al., 2016; Lubbe, 2008). The tactile system provides information related to shape, size and the texture of objects that are felt on the skin. This information allows for a better understanding of surroundings (Bundy, et al., 2002). The foetus has also developed sensitivity in its mouth inside the womb (Lecanuet & Schaal, 1996; Lubbe, 2008). In the 14th week, the foetus is able to feel touch all over the body, except the back and head. By 26 weeks, primitive tactile reflexes can be elicited; rooting is present as well as the back and legs modulate input by 32 weeks gestation (Lecanuet & Schaal, 1996). The tactile system is developed early in the gestational period to help the foetus with sensations such as temperature, pain and proprioception (Case-Smith & O'Brien, 2013; Lubbe, 2008). This system functions as a protection and discriminatory system, the purpose of which is to create security within the uterus of the mother (Lecuona, et al., 2017). In the second trimester, the foetus also becomes sensitive to touch (Lubbe, 2008).

When an infant is born at a viable gestational age, which is 21 weeks gestational age (Lubbe, 2008), the infant is able to perceive pressure, pain and temperature (Faure, et al., 2016). The use of mother–infant skin-to-skin contact (more commonly known as Kangaroo Care) at this stage has been shown to affect the self-regulatory processes of premature infants in terms of their tactile systems. Feldman and Eidelman, in their study, matched 73 infants who received Kangaroo Care with 73 infants who did not for birth weight, gestational age, medical risk, and family demographics. No differences between Kangaroo Care infants and the controls groups were found before Kangaroo Care, but at term, Kangaroo Care infants showed additional mature state distribution and organised sleep–wake cyclicity (Feldman & Eidelman, 2003). This, and the infants' higher thresholds for negative emotionality and more efficient arousal modulation when attending to increasingly complex stimuli at three months of age, emphasises the importance of correct and appropriate tactile stimulation within the NICU (Feldman & Eidelman, 2003).

The whole tactile system is, however, extremely sensitive and easily over-stimulated (Moore, et al., 2018). This can result in tactile defensiveness or an over-active protective response. Behaviours that can be noted and result from over-stimulation of the tactile system include pulling away from a stimulus, squirming, crying, inability to settle/get comfortable and feeding aversions (Faure, et al., 2016; May-Benson, et al., 2009).

The infant may also present with unresponsiveness of the tactile system and having an over- or under-responsive tactile system due to prematurity can affect relationships with parents, caregivers and siblings due to inappropriate response to touch. Tactile defensiveness can lead to other developmental delays as infants for example do not like clothing touching their skin and thus do not learn to dress themselves or they take longer to crawl as they do not like the grass or carpet touching their legs (Bundy, et al., 2002; Case-Smith & O'Brien, 2013).

The sensation of pain is an important component of the tactile system and the central nervous system structures responsible for the transmission of painful stimuli are present at around 24 weeks gestation (Furdon, et al., 1998). Numerous procedures required in the NICU affect the infants' perception of pain and can result in over-stimulation in premature infants. Pain in premature infants is difficult to assess. Côté, et al., (1991) report that premature or critically ill infants may become unresponsive in response to painful stimuli with a disruption of sleep patterns (Côté, et al., 1991). However, pain assessment is a persistent clinical problem with inadequate assessments of pain in premature infants. The development of the Premature Infant Pain Profile (PIPP) is now being used in clinical practice to assist in identifying pain and thus possibly assisting in preventing sensory problems in preterm infants with regard to overstimulation of the tactile system (Stevens, et al., 2014).

2.4.1.2 Vestibular System

The vestibular apparatus, in the inner ear, can be distinguished within the vestibular system at five weeks gestation in the embryo (Bundy, et al., 2002). In the sixth week of gestation, the vestibular system, which includes the vestibular apparatus, starts to develop the cortical structures. This system will be responsible for balance, stability, posture and orientation of the body in space later in life through its involvement in reflex actions (Lecanuet & Schaal, 1996; Lubbe, 2008; Faure, et al., 2016; Lane, et al., 2019).

The Moro reflex is the first known response to vestibular input with other reflexes, such as yawning, sucking and swallowing, following at 11-12 weeks gestation (Lecanuet & Schaal, 1996). Head retroflexion and head rotations are common events that are the first approach response seen as a function of the vestibular system related to movement sensations, which are particularly critical for sensory development. Fidgety movements usually occur around nine weeks and are present until 20–25 weeks gestation, when the vestibular system supports intentional and antigravity movements. At this stage, the foetus is able to orientate itself in the uterus using vestibular input and movement of the limbs. The vestibular system is fully functional after the 25th week of gestation, when the foetus also starts to demonstrate the righting reflex (Ayres, 1979; Lecanuet & Schaal, 1996).

Lower gestational age is potentially associated with abnormal reactivity to deep pressure and vestibular stimulation in preterm infants. This has been associated with the loss of maternal movement and the amniotic fluid, which creates gentle oscillating movements providing vestibular stimulation (Lecanuet & Schaal, 1996; Lubbe, 2008). The premature infants do not experience this input, and this can lead to difficulties later when the infant becomes a toddler (Adams, et al., 2015). Children who are affected by an immature vestibular system often appear to be inattentive, lazy, overly anxious, or seeking attention. Functioning at school, performing routine daily tasks, or just getting out of bed in the morning may be difficult for these children (Ayres, 1979; Bundy, et al., 2002).

Research reveals children with vestibular difficulties experience vertigo, dizziness, visual problems, hearing difficulties, balance and spatial orientation problems. This affects balance and difficulty walking straight or when turning, clumsiness, poor coordination or maintaining a straight posture. These children also experience head tilting to the side, tendency to look downward to confirm the location of the ground, tendency to touch or hold onto something when standing, or to touch or hold the head while seated (Case-Smith & O'Brien, 2013; Machado, et al., 2017; Msall & Tremont, 2002).

2.4.1.3 Proprioceptive System

Towards the end of the first trimester, approximately 12 weeks gestation, the proprioceptive system starts to develop (Lubbe, 2008; Faure, et al., 2016). The proprioceptive system provides information to the brain about when and how muscles and joints are working – contracting, stretching, bending, extending, being pulled or compressed (Ayres, 1979; Bundy, et al., 2002; Case-Smith & O'Brien, 2013; Lane, et al., 2019). As the proprioceptive system develops, and once sensory information has been processed correctly, the foetus becomes aware of each body part and how it moves effectively. The foetus is thus able to perceive their position and motion of their limbs and joints within the uterus (Bundy, et al., 2002; Lubbe, 2008).

A premature infant does not develop adequate proprioception in the uterus, particularly with regard to the proprioception of the head, which develops at the end of gestation to aid the foetus in turning themselves in preparation for the birthing process (Ayres, 1979; Faure, et al., 2016). If adequate proprioception does not develop, the infant will struggle with their ability to position themselves in space as well as have difficulty in coordinating their movements. This can be disorganising for an infant and lead to sensory overload (Ayres, 1979). Poor proprioception in a developing infant can have an effect on their ability to function in day-to-day society; they are often clumsy, as they do not know where their own body is in space, thus they may injure themselves. They also have difficulty writing, with a tendency to have increased or decreased pencil pressure, or putting their clothes on in the correct way due to their inability to identify the boundaries of their own bodies in relation to objects (Case-Smith & O'Brien, 2013).

2.4.1.4 Gustatory System

The gustatory system refers to the ability of recognising and interpreting information taken in through the sense of taste. Difficulties with gustatory processing affect how this information is interpreted or processed by the brain (Bundy, et al., 2002). In the fourth week of gestation, the mouth of the embryo begins to form, and the tongue develops around the eighth week (Lecanuet & Schaal, 1996). Taste buds also appear in the eighth week of gestation and the foetus is able to transmit actual taste sensations by the 13^{th} to 15^{th} week of gestation. When the gustatory system is developed, the foetus is able to taste everything the mother eats, through the amniotic fluid; this is possible as the taste molecules of the food are absorbed in the amniotic fluid and the foetus swallows the amniotic fluid (Lubbe, 2008). By the end of the first trimester, by 26 to 28 weeks gestation, the taste receptors in the brain are developed and the foetus is able to withdraw from bitter tastes (Lecanuet & Schaal, 1996; Lubbe, 2008). At 35 weeks, the foetus can differentiate between glucose and water. The gustatory system encourages exploration, facilitates developmental skills of hand-to-mouth, readiness for oral feeding, midline play once the baby has been born and differentiation between sweet, sour, bitter and salty tastes (Lecanuet & Schaal, 1996). The foetus is constantly exposed to the mother's taste, which provides gustatory stimulation. However, this is not always the case for preterm infants as they are often deprived of this when they leave the uterus early (White-Traut & Norr, 2009).

2.4.1.5 Olfactory System

Olfaction was thought to be almost a non-functional sensory system in newborn infants and it is only in the last few decades that it has been shown to be important for day-to-day functioning (Schaal, 2017). The olfactory system develops in the second trimester, and is able to respond appropriately to smell stimuli (Case-Smith & O'Brien, 2013). In the fifth week of development, the nasal pits are present and at eight weeks, the nasal structure and components are formed (Lecanuet & Schaal, 1996). This system interlinks with the gustatory system (Schaaf & Smith Roley, 2006), but the olfactory neurons develop earlier in gestation. A plug-like tissue fills the foetus' nasal cavity between eight weeks and 24 weeks to prevent some smells reaching the applicable receptors in the brain and thus the ability to smell only begins at week 28 of gestation (Lubbe, 2008). The olfactory molecules dissolve in the amniotic fluid and thus the foetus is able to smell while in the uterus (Lubbe, 2008).

The system of smell has the main purpose of recognition and identification. It is one of the most well-developed senses in a newborn, to allow for the elicitation of adaptive behaviours such as breast feeding and rooting. It also allows the baby to recognise a mother through smell (Ayres, 1979; Bloomfield, et al., 2017; Lecanuet & Schaal, 1996).

An interrupted neuro-developmental system in a premature infant can thus have difficulty processing olfactory information. Premature infants in an incubator do not experience the exposure to odours and do not develop odour preferences for caregivers. This can affect the manner in which their nervous system manages the incoming information and can result in infants having difficulty in rooting, affecting feeding. Tube feeding in a premature infant will result in a lack of pre-feeding actions, including the recognition of the smell of breast milk since these odour references do not exist in the typical incubator. The recognition of particular individuals or settings is also impacted, thus affecting the formation of sound bonds with their mothers (Lubbe, 2008; Schaal, 2017). Deficits in olfactory processing can also affect arousal states, sleeping behaviour, elicit negative emotional behaviour and affect the development of preferences in social domains as infants recognise familiar caretaker odours, which calm them (Doty, 1992; Schaal, 2017).

2.4.1.6 Auditory System

At four weeks gestation, the first signs of an auditory anatomical structure start to appear. (Lecanuet & Schaal, 1996; Moore, et al., 2018). At 16 weeks gestation, the foetus' auditory system is able to respond to auditory information before the auditory apparatus has completely developed. At 23 weeks, the cochlea and lower brain stem auditory areas develop and the foetus responds to low to mid pitched sounds. The frequencies the foetus can hear are between 83 to 5000Hz as of 23 weeks gestation. The foetus is able to hear by 24 weeks gestation, as the ear is fully developed, yet can only discriminate between sounds during the third trimester (Lubbe, 2008). The auditory system is fully developed at 28 weeks in the womb and a foetus will have had 12 weeks of auditory input by week 28 (Bundy, et al., 2002). Voices of the mothers during normal daily activities, along with the sounds produced by her body and those present in her usual surroundings, are sufficient for normal foetal auditory development (Krueger, et al., 2012).

A preterm infant will not be used to the environmental sounds within the NICU environment, thus making the ability to habituate auditory information difficult. This makes the auditory system very sensitive (Faure, et al., 2016). Some observed behaviours in response to increased auditory levels in the NICU include changes in colour, heart rate and respiration rate, desaturation in oxygen levels, inability to sleep as well as increased motor activity (Faure, et al., 2016; May-Benson, et al., 2009) Premature infants in the NICU lose both their protective barrier from high frequency noise, and the rhythmic, more predictable acoustic environment of the uterus and this may disturb the development of their auditory systems and auditory-cortical circuits. The potential lack of language stimuli and voices in general in the NICU may contribute to delayed language development (Chow & Shellhaas, 2016; Wachman & Lahav, 2011). Recommendations have been provided for noise in the environment of the High-Risk Infant Centres by a multidisciplinary group of clinicians and researchers (Krueger, et al., 2012), based on a review of the literature and the best available evidence regarding the effect of sound on the foetus and preterm infant. They suggest care practices must provide enough opportunities for at risk infants in the NICU to hear their parent's voices. Earphones and other devices attached to the infant's ears, however, should not be used as there is little evidence to support the use of recorded music or speech in this environment (Krueger, et al., 2012).

Auditory sensory overload can have an impact on children's participation in academic and social activities (Ayres, 1979). Parents of children with sensory sensitivities in a school-age range, reported higher frequencies of early and coexisting internalising, externalising, and dysregulation problems, and lower levels of coexisting adaptive social behaviours, which are everyday skills needed to function and meet the demands of their social environment (Ryckman, et al., 2017). The prevalence of sensory overload and their relationship to social-emotional problems and competence has, however, not been thoroughly studied (Ryckman, et al., 2017).

2.4.1.7 Visual System

The visual system starts to develop around the 22nd day of gestation when the eye formation begins. Around this time, the retinal differentiation takes place and at 12 weeks gestation, precursors of rods and cones start to form followed by all retinal layers at 22 weeks gestation (Lubbe, 2008; Moore, et al., 2018). At 23 to 24 weeks, the immature rods and cones develop followed by the myelinisation of optic nerve and at 25 to 26 weeks gestation all neurons of the visual cortex are formed. The eyes begin to open around 28 weeks, with general rapid ocular growth and at around 31 weeks gestation, the iris sphincter develops followed by the retinal vessels, which reach the periphery (Lecanuet & Schaal, 1996; Moore, et al., 2018). At 30 weeks gestation, 75 eye movements can be detected, which aid in monitoring behaviour states.

Premature babies, born earlier than 27-28 weeks gestation, have the possibility of their eyes being sealed shut and or possibly having a hazy cornea. Infants will have difficulty with awake visual attention if born prior to 32 weeks and they will have difficulty in controlling the amount of light into the retinal field (Faure, et al., 2016). In a study on eye care for newborn infants, phototherapy was found not to be free from side effects, and newborn infants who were subjected to phototherapy for six to 15 days showed changes in the red reflex test (Atkinson & Braddick, 2007). It was also found that eye modifications, arising from phototherapy, could be caused by accidental exposure to light due to the use and/or inappropriate positioning of the eye shield used in phototherapy (Atkinson & Braddick, 2007).

Prematurity may result in a lack of maturation past the neonatal period, with atypical development of the visual system particularly in terms of visual tracking, attention to stimuli and visual regard and disengagement ability. Infants born prematurely may show deficits on visual tests of attention, measures of early visual cortical function, orientation reversal visual event-related potentials and fixation shifts. These deficits identified in later life affect the visual perception and performance in activities of daily living and academic performance (Atkinson & Braddick, 2007).

2.4.2 Foetal behaviour states

Foetal behaviour states are indicative of normal development in utero and are influenced by the infant's sensory development (Lubbe, 2009). They start to develop in the third trimester and consist of sleep and wake states. Development of foetal behaviour states starts around 28 weeks gestation until 36 weeks, when they are fully developed (Crozier, et al., 2016; Lubbe, 2009). Four different sleep awake states can be identified in the womb in the third trimester, quiet sleep and active sleep, quiet awake and active awake. The quiet sleep state is recognised at 31 weeks gestation, this is when the foetus' eyes are closed and the heart beat and breathing are regular (Lubbe, 2008). A foetus who has poor sleeping patterns in the uterus may also experience poor sleeping patterns when born. Premature infants do not have enough time in the uterus to develop behaviour states and thus struggle to form sleep patterns when born (Lubbe, 2008). Preterm infants may spend 80% of their time in the more disorganised active sleep compared to the 50% of full-term infants (Waitzman, 2007).

The foetus' behaviour is directly influenced by the foetal environment, such as bodily hormonal changes, eating patterns and bodily movements (Flanagan, et al., 2019). Mothers who are highly anxious and stressed may experience a more active foetus within the uterus and babies who are irritable (Crozier, et al., 2016; Lubbe, 2009).

The uterus, however, effectively limits and regulates the amount, type, and duration of sensory stimulation on the sensory abilities of the foetus that occur during the gestational period (Faure, et al., 2016; Lubbe, 2009). This pattern of sensory stimulation is fundamentally altered by premature birth, with significant changes in normal patterns of tactile, vestibular, proprioceptive, olfactory, auditory, and visual stimulations. For example, preterm infants in the NICU receive smaller quantities of tactile-vestibular stimulation resulting from maternal movement and being in the uterus, yet there are significant increases in other types of stimulation that are not present in the womb environment, such as excessive handling (Faure, et al., 2016; Lubbe, 2009; Machado, et al., 2017). This reality can have lasting effects on the developing brain and interfere in the natural development of sensory systems resulting in difficulties in sensory modulation (Courchia, et al., 2019; Machado, et al., 2017).

2.5 Neonatal Intensive Care Unit: Environmental factors and Sensory Input

Neonatal Intensive Care Units and Neonatal High Care Units are the best place for a preterm infant to be, if not in the uterus, as they contain all the support the infant needs to survive but this is a biologically atypical environment, which is not as conducive to development (Anderson, 1986; Lubbe, 2008). A NICU/NHCU is designed with environmental factors that provide inappropriate forms of stimulation that may affect the infants' sensory development (Anderson, 1986). Bright lights, high-pitched noise, techniques that may be invasive, constant handling and positioning of the preterm infant may result in stress reactions due to sensory overload from environmental stimuli (Lubbe, 2008). It has been found that these infants are considerably compromised by a prolonged stay (more than 1 week) in the NICU/NHCU (Case-Smith, et al., 1998).

These infants are also at risk of developing sensory processing difficulties. Their immature, disorganised nervous systems are not ready to process the sensory information overload of the NICUs (Anderson, 1986; Lane, 2002). These difficulties may have a further impact on the infant's development (Lecuona, et al., 2017), with the tactile and vestibular systems playing a primary role in the development of sensory processing with associated responses to both touch and movement (Case-Smith & O'Brien, 2013). Abnormal reactivity may relate to the altered sensory experiences preterm infants encounter in the NICU environment. Research has shown that NICU/NHCU environments may result in the infants being over-responsive to stimuli (Mitchell, et al., 2015). There is some controversy, in that one author found the infants to be more under-responsive within the NICU/NHCU (Wickremasinghe, et al., 2013). This may be due to the infants shutting down due to over stimulation and thus they do not appear to react to sensory stimuli within their surroundings even though they are overstimulated. However, in the NICU, the tactile, vestibular, proprioceptive, olfactory, and gustatory input may be reduced resulting in under stimulation, while continuous tactile, auditory and visual input results in the premature infant receiving over stimulation (Mitchell, et al., 2015; Wickremasinghe, et al., 2013).

Vestibular and proprioceptive input can be compromised by supine immobilisation and unopposed gravitational forces during critical windows of neurological development (Machado, et al., 2017). This inappropriate positioning of a preterm infant can result in abnormal tone, with delay in their motor development, as they have poor muscle strength resulting in the infants taking longer to adapt to movement (Lubbe, 2009; Machado, et al., 2017). The preterm infants have more extensor tone than do full term infants, which interferes with the development of later head control, rolling over and getting into and out of sitting. Positioning in supine is therefore contra-indicated since the flexed position mimics the in-utero condition, which supports the development of flexor tone providing a sense of containment, allowing the infant to better self-organise (Aucott, et al., 2002). Supine lying also compromises sensorimotor feedback, so learning and exploring in their environment with feedback through their hands, face, and other body areas does not occur (Aucott, et al., 2002; Lubbe, 2009).

The lack of gustatory, oral and visual exploration of the hands as well as vestibular and proprioceptive sensory input affects overall sensorimotor development. Supportive positioning also provides stability for behaviour states, making the infant calmer and increases quiet sleep (Aucott, et al., 2002; Lubbe, 2009; Waitzman, 2007). Feeding of the infant in an unsupported position in the NICU also results in the infant not remaining alert long enough to complete the feed. It is suggested that positional support and proper swaddling should be provided (Vegara & Bigsby, 2004); this can decrease energy expenditure and provide sensory input resulting in behavioural organisation (Vegara & Bigsby, 2004).

Handling a preterm infant excessively can lead to physiological and behavioural stress. It has been recommended that most NICUs adopt a minimal handling and stimulation approach for very immature infants (Ashbaugh, et al., 1999). When moving or handling the infant, attention to physiological parameters such as heart and respiratory rate, oxygen saturations and ease of breathing should be considered. If infants are physiologically stable, they should be handled gently, and tactile, vestibular and kinaesthetic stimulation, to provide input to their systems, should be given (Moyer-Mileur, et al., 2000). Handling that occurs during medical procedures does not necessarily take the infant's state into account and may not be gentle, which results in pain with overstimulation of the tactile system (Aucott, et al., 2002; Côté, et al., 1991). For example, an infant in the NICU/NHCU who has needed to have blood repeatedly drawn might be sensitive to touch in the future (Lombard, 2007; Stevens, et al., 2014).

Constant light can disturb the preterm infant's body rhythm, which in turn disturbs the sleep-wake cycle and prevents the preterm from opening their eyes, therefore affecting attention (Lubbe, 2009). Bright lights may have a damaging effect on the development of the visual system due to the amount of light received by the infant (Holmes, et al., 1982; Fielder & Moseley, 2000; Lubbe, 2009).

A noisy environment can cause tachycardia, tachypnoea, apnoea, oxygen desaturation, increases in mean arterial blood pressure, disturbance in sleep, disturbed sleep and even intracranial haemorrhage in very low birth weight infants due to increased blood pressure (Wachman & Lahav, 2011). Infant Intensive Care Units should therefore include a system of regular noise. Sound limit recommendations are to maintain a nursery with a-weighted, slow response scale and possibly develop and maintain a programme that allows for noise reduction in order to operate within the recommended permissible noise criteria (Krueger, et al., 2012). The NICU should provide an environment that will protect sleep, support stable vital signs, improve speech fluency for the infant, and reduce potential adverse effects on auditory development (Chang, et al., 2001; Krueger, et al., 2012).

An infant who is stressed or sick tends to reach sensory overload faster than one who is not. An optimal environment needs to be established in the NICU/NHCU in order to avoid sensory overload, as the arousal levels of infants in sensory overload often increase and a flight/fight/fright response is triggered (Dunn, 1997; Lombard, 2007). Thus, essential environmental conditions should be observed to determine if these have an effect on whether infants over-respond or under-respond to the sensory information (Bundy, et al., 2002).

A checklist, the Implementation of Neurodevelopmental Supportive Care (INDeSC) was designed by Welma Lubbe as an observation tool to assist in assessing the NHCU/NICU environment (Lubbe, 2009). This is to ensure that the environment the premature infant is in, is replicating that of a uterus, or is as uterine-like as possible, to allow for optimal growth (Aucott, et al., 2002; Lubbe, 2009). The INDeSC checklist comprises nine neurodevelopmental supportive care (NDSC) categories:

- The Neonatal Intensive Care design
- Individualised care
- Family-centred care philosophy
- Infant positioning
- Handling techniques
- Environmental manipulation
- Pain management
- Knowledge of infant development
- Feeding

Should the criteria for these categories be adhered to within each environment, this can promote sensory integration and modulation within the premature infants (Aucott, et al., 2002; Lubbe, 2009). The INDeSC has been used in previous South African studies in both the public and private sector NICU (Lubbe, 2009; Rheeder et al., 2017).

2.5.1 Sensory modulation in preterm infants

Sensory overload, overstimulation or underload, as seen with preterm infants in NICU, results in the inability to successfully process, organise and interpret environmental sensory information (Bundy, et al., 2002; Lombard, 2007; Schaaf & Smith Roley, 2006). These infants are unable to control their reaction towards sensory input (Williamson & Anzalone, 2001), which constitutes a sensory modulation disorder (SMD) as either over responsivity, under responsivity or sensory craving (Bundy, et al., 2002; Miller, et al., 2007). This has been associated with the cumulative effect of medical complications associated with premature birth and sensory experiences in the NICU environment in the early stages of development (Case-Smith, et al., 1998; Machado, et al., 2017). Sensory modulation disorder in preterm infants has been associated with difficulties in temperament and developmental delays. According to Case Smith et al. (1998), preterm infants showed additional frequent behaviours that included tactile defensiveness and difficult temperament, followed by sensory seeking behaviours and high activity levels. Preterm infants with developmental delays were found to have a higher prevalence of over responsivity in comparison to the typical developing group indicating development delay (Baranek, et al., 2007). While the infant’s development is moulded by genetic makeup and experience, sensory experiences in particular also play a role, which has an impact on behaviour and learning, which further influences developmental delay (Schaaf & Smith Roley, 2006).

Research on premature infants has reported on sensory modulation dysfunction, for predominantly the auditory and tactile systems, with indications that over responsivity in the tactile system was the most common dysfunction (Mitchell, et al., 2015).

Different levels of sensory input link to different arousal levels based on the sensory input received throughout the day (Lombard, 2007). This supports the work of Dunn, who developed a model on an infants or child’s response to sensory events. She suggested there was an interaction between the neurological threshold and the behavioural response (Dunn, 1997). She proposed four basic patterns (quadrant patterns) of sensory modulation based on two thresholds: infants with a low sensory threshold who notice and respond to stimuli more often because their neurological system activates more easily to sensory events and infants with a high sensory threshold who miss stimuli because their neurological system requires stronger stimuli to activate it (Dunn, 2005).

Dunn indicates there is a continuum of self-regulation in relation to sensory modulation. At one end of the continuum are infants who have a passive strategy towards sensory events, reacting with distress when sensory events make them uncomfortable. At the other continuum are infants who utilise an active strategy, adjusting to get a manageable amount of sensory input. Therefore, the quadrant patterns resulted from the intersection of the neurological threshold and self-regulation and are: (1) sensory seeking (high threshold and active self-regulation strategy), (2) sensory avoiding (low thresholds and active self-regulation strategy), (3) sensory sensitivity (low threshold and passive self-regulation strategy), and (4) poor registration (high threshold and passive self-regulation strategy) (Figure 2.1).

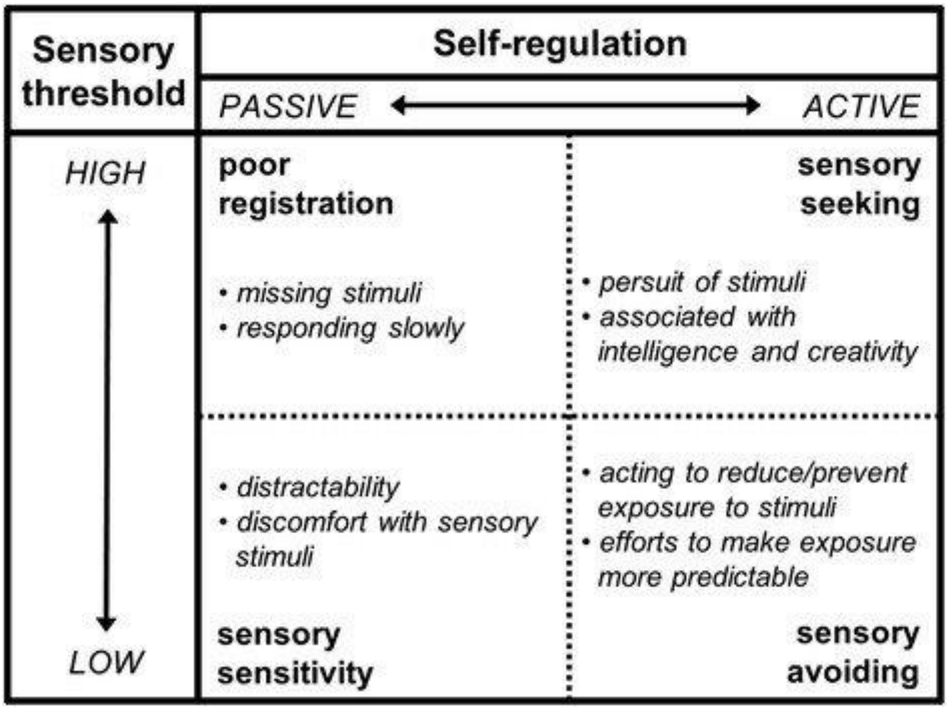

Figure 2.1 Sensory quadrants – ***Dunn W. The impact of sensory processing abilities on the daily lives of young children and their families: A conceptual model Infants Young Child, 1997, 9, 23–35***

Premature infants may use any of these patterns to deal with sensory input, but it is important for infants with low sensory thresholds to be able to process the sensations so they can self-regulate to maintain a functional level of arousal. Premature infants struggle to self-regulate and therefore it is vital to maintain a level of function and arousal that is equivalent to level two described by Lombard (2007). At this level the correct amount of seeing, hearing, smelling, touching, moving and tasting for a preterm infant's brain in the NICU/NHCU and "good" stress keep the infant alert and motivated (Lombard, 2007), and this can be aligned with "typical performance-like majority" on the scoring used by Dunn on the Sensory Profile (SP), to assess infants' sensory modulation (Dunn, 2014). At this level, there are no signs of irritability, anxiousness and emotional deregulation. Level one, which is even more desirable, is rarely achieved in the NICU, which allows the body to manage all the information received from the environment in an optimal manner that mimics the environment of the uterus (Lombard, 2007).

At levels three, four and five of function and arousal, the infants will find it difficult to regulate and process the sensory stimuli. Level three, is the level where the sensory intensity starts to override drive and output. This is when the “good” stress starts to turn into “bad” stress resulting in irritable, anxious and emotionally based behaviour (Lombard, 2007). This level is equivalent to behaviour described as probable difference - *more than others* on the scoring used by Dunn on the Sensory Profile (SP), to assess infants’ sensory modulation (Dunn, 2014).

Level four represents infants with extreme responses to sensory events, and are likely to present with a break-down of function and marked with fright, aggression and resilience to thrive. Often, this is seen as a negative emotional reaction and cause the breakdown of relationships with carers. This level is equivalent to behaviour described as definite difference - *much more than others* on the scoring used by Dunn on the Sensory Profile (SP), to assess infants’ sensory modulation (Dunn, 2014). Infants are unable to function and participate at this level and may move to level five, the shutdown level, where the infant becomes depersonalised and dissociated from their environment; this has a negative impact on the infant’s health and wellness (Lombard, 2007).

Infants with high sensory thresholds, however, may be under responsive to stimuli if they receive inadequate input in the NICU. This is equivalent to behaviour described as probable difference - *less than others* or definite difference - *much less than others* on the scoring used by Dunn on the Sensory Profile (SP), to assess infants’ sensory modulation (Dunn, 2014).

It is important to identify infants at risk of SMD and developmental delays as early as possible. Standardised tests, such as the Infant/Toddler Sensory Profile 2 (Dunn, 2014) and the Bayley-III Scales of Infant and Toddler Development ® – Third Edition (Albers, et al., 2007), are used to determine deficits in these areas. A recent study confirmed these assessments identify deficits in high-risk infants (Flanagan, et al.,

2019) and enable a more precise evaluation, which improves the efficacy of early intervention (Shenai & Bijlani, 2010).

A study by Bart et al. (2011) assessed the differences in sensory modulation between late preterm infants (LPI) and control groups using the Sensory Profile™. Substantial differences were found between the LPI and term infants' groups with regards to oral and auditory sensory modulation, indicating a greater risk of the LPI potentially developing SMD compared to term infants (Bart, et al., 2011). They further suggested that cortical functioning is impacted upon by the role of gestational age in LPI and term infants (Bart, et al., 2011). Approximately 10% of the sensory modulation of participants in their study was explained by gestational age and head circumference, which is a characteristic of the preterm population. Variations in sensory modulation and other longstanding neurocognitive deficits may be explained by the immature brain (Bart, et al., 2011). Only the multiple gestations and the head circumference explained the variance of participation (16%) and parental satisfaction (13%) in the study (Bart, et al., 2011). The results of this study, in particular show that LPI is a group at risk of developing sensory modulation disorder, with equally lower levels of participation, and decreased parental satisfaction with their children's participation. This stems in part from the factor of the infant's immaturity, and partly because of environmental factors (Bart, et al., 2011).

There is a need for more research on SPD, including sensory modulation in children born prematurely (Ryckman, et al., 2017). A study by Adams et al. (2015) showed a higher percentage (37% vs. 12%) of preterm infants having significantly more sensory problems than full term infants once reaching pre-school. These sensory problems were associated with lower scores on the Short Sensory Profile (SSP) total score and five of seven subscale scores, indicating that the sensory symptoms were not specific to a single sensory domain (Adams, et al., 2015).

2.6 Summary

The World Health Organization classifies prematurity into extremely premature (< 28 weeks); very premature (28 to <32 weeks) and moderate to late prematurity (32 to < 37 weeks) (World Health Organization, 2018). An estimated 15 million babies worldwide are born prematurely every year, and this is the leading cause of mortality in children under the age of 5 years old (World Health Organization, 2018).

These premature infants often do not have enough time to have developed mature sensory systems, and are at risk of developing sensory processing difficulties (Anderson, 1986). With the optimal environment established in the NICU/NHCU, sensory overload can be avoided and sensory stimulation enhanced (Lombard, 2007; Lubbe, 2009).

Should these infants be identified early within the first six months of life, it is possible to stimulate sensory integration and normal development; without assistance, these infants may have difficulty in all spheres of life, with difficulty modulating sensory information. Therefore, there is a need for further research pertaining to the demographics, environmental factors and development and sensory modulation in preterm infants to be able to identify these infants while still within the NHCU/NICU to assist with early intervention.

CHAPTER 3: METHODOLOGY

3.1 Introduction

In this chapter, the methodology of the study that was followed, is described. The research design, the research site and the study population's parameters are presented. The inclusion and exclusion criteria, as well as the sampling and procedure for recruiting participants are further described. Details regarding the measuring instruments are provided, followed by information regarding the study and the data collection process. Finally, the data management, as well as ethical considerations that were adhered to during the study, are described.

3.2 Study Design

The study used a quantitative, non-experimental, descriptive, research design. A quantitative, non-experimental approach allowed the researcher to collect and analyse numerical data of the preterm infants while they were still in the Neonatal High Care Unit (NHCU), without altering their environment within Edenvale General Hospital. The cohort for this study was formed by a sample of preterm infants who were admitted to the NHCU This research described the NHCU environmental factors assessed while the infants were in the NHCU, and sensory modulation using the Infant Sensory Profile™ in 22 of the preterm infants at 4 weeks post discharge. The 10 infants who returned at 3-6 months post discharge (corrected age) were reassessed for sensory modulation and developmental milestones.

In order to determine the effects of the stay in NHCU on sensory modulation, any changes in the infants' sensory profiles at 3-6 months (corrected age) were described. At this stage, the sensory modulation of the preterm infants was compared with their developmental level, using the Bayley-III assessment. The nature of the existing relationship between the associated variables of NHCU environmental factors and sensory modulation are presented, as well as the existing relationship between sensory modulation and normal development for a cohort of preterm infants (Kielhofner, 2006).

This research method was suited to this particular study as it allowed for the collection of data in a specific environment (NHCU) as well as the assessing of a small number of preterm infants that were in the NHCU environment at a specific time.

This study consisted of two phases:

3.2.1 Phase 1: Situational analysis of the neonatal high care unit and assessment of the infants' sensory modulation

The first phase consisted of two parts.

Part 1 was the collection of data on demographic and environmental factors related to the NHCU, at the time the infants were in the NHCU at Edenvale General Hospital, through a situational analysis of the NHCU.

In **Part 2,** the infants' sensory modulation was assessed to determine their sensory profile at 4 weeks post discharge when they returned for a neonate follow-up appointment. This time frame allowed for the infants to spend time at home with their mothers before the mothers were asked to report on their sensory behaviour, and allowed the infants to experience an environment that differed from the NHCU environment. The infants' sensory prolife was used to establish if infants, who spent time in the NHCU at Edenvale General Hospital, did present with a risk for sensory modulation disorder (SMD).

The association of the demographic factors and the sensory profile reported for the infants was described. The sensory profile of the infants was further compared with the neurodevelopmental supportive care (NDSC) criteria met in the NHCU.

3.2.2 Phase 2: Sensory modulation and normal development at 3-6 months (corrected age)

The infants were followed up again at the age of 3-6 months (corrected age), with their sensory modulation assessed as well as their normal development in all spheres, including motor, cognitive and language skills as well as social-emotional and adaptive behaviour. The infant's sensory responsivity and their normal development scores was compared to establish which areas of development could be affected by SMD.

3.3 Research Site

The research site was the NHCU at Edenvale General Hospital, a public district hospital in an urban environment within Johannesburg, South Africa. Settings of early intervention service delivery are the Neonatal Intensive Care Unit (NICU) and NHCU in South Africa's public sector; neonatal care is provided at district hospitals in the form of NHCU and Kangaroo Mother Care (KMC) units (Strasheim, 2009). These units provide intensive care to genetically predisposed, premature and low birthweight infants, as well as other infants who require additional care. Tertiary hospitals, also commonly called or described as teaching hospitals, provide neonatal care in the form of NICUs that have specialised equipment. If the infant does not need specialised care in the NICU, they are admitted at birth for neonatal care to the NHCU at district or regional hospitals until the infant achieves full-term age, achieves an acceptable heart rate and is adequately fed orally (Strasheim, 2009).

The NHCU at Edenvale General Hospital contains a maximum of eight incubators in the NHCU. Within the NHCU there were fluorescent lights that were constantly on. The full multidisciplinary team, comprises a minimum of three doctors, one speech therapist, one occupational therapist, and a minimum of four nurses. Staff members are aware of the neonatal operational guidelines, yet it appears to be only partially implemented. Furthermore, not all staff members have attended training on NDSC.

Mothers were allowed in the NHCU throughout the 24-hour day and fathers only during visiting hours. Children, extended family and any other visitors were not allowed inside the NHCU. Kangaroo mother care was provided on an ad hoc basis; however, it was continued and constant when the infant was moved to the KMC ward.

3.4 Study Population and Sample Size

The study population was all preterm infants admitted in the NHCU at Edenvale General Hospital, between the months of September 2016 and March 2017.

Convenience sampling was used as the researcher was based within Edenvale General Hospital on a daily basis and had access to the population of preterm infants (Kielhofner, 2006). Parents of all infants who met the inclusion criteria were approached to participate in the study. This ensured that the sample size allowed for reliable and valid results. All preterm infants admitted into the NHCU who met the following inclusion and exclusion criteria and whose parents/caregivers agreed to participate were included in the study (Table 3.1).

Table 3.1 Inclusion and exclusion criteria

Inclusion	Exclusion
Age <37 weeks admitted into the NHCU Spent at least 1 week in the NHCU	APGAR Score <7 at ten minutes

The exclusion criteria of an Apgar score lower than 7 at ten minutes was used to eliminate infants who may have neurological deficits, as the purpose of this study was to focus on infants who were premature and may have sensory processing difficulties.

3.4.1 Sample size

Approximately 10 preterm infants were admitted to the NHCU per month. It was estimated that over a six-month period, approximately 60 infants could be included in the study. Based on this population, a sample of 31 infants was needed to represent the population with a 5% margin of error, as recommended using Cochran's formula for ordinal data. Applying a modification of Cochran's formula (for small sample sizes): assuming p= 0.5 and 95% CI: where: e= 0.1 for a 10% margin of error, a sample size of 26 infants was required (Bartlett, et al., 2001).

3.5 Research Instruments

3.5.1 Demographic Information

The demographic information was collected on the infants and included the following: date of birth of the infant, parents/caregivers' contact number, complications of pregnancy and gestational age (Appendix A). Information was further recorded from the premature infant's medical file. The researcher collected this information from the infant's file on the day the premature infant's mother signed the consent form. This information included the following: birth weight, APGAR score at 5 and 10 minutes, heart rate, respiratory effort, muscle tone, reflex or irritability, colour, measurement (head circumference; abdominal circumference; length), temperature, pulse and breathing rate (Appendix B). The time spent in the NHCU was recorded on discharge.

3.5.2 Implementation of Neurodevelopmental Supportive Care Checklist

The Implementation of Neurodevelopmental Supportive Care (INDeSC) checklist was used to understand and describe the essential environmental factors within the NHCU (Appendix C). This checklist was designed in South Africa and based on observations on how these units are run. The checklist was tested for and had good content validity, construct validity, face validity and criterion validity (Lubbe, 2009).

The INDeSC comprises of nine categories; each category has sub-questions that clarify what exactly should be observed in the NICUs, NHCUs, growing preterm infant wards and KMC environment (Lubbe, 2009). By basing the INDeSC checklist on latest evidence from an integrated literature review, the content validity was warranted. Nursing experts in neurodevelopmental supportive care and general neonatal care, reviewed the checklist to ensure appropriateness and accuracy. Construct validity was ensured by conceptualisation of constructs from literature, and a pilot test was conducted by Lubbe (2009), followed by an independent reviewer who verified the translated components as accurate to ensure face validity (Lubbe, 2009; Rheeder, et al., 2017). Through qualitative research, such as interviews and observations, it was determined that the INDeSC checklist's reliability was sensitive to time and the place it was performed. As it was not consistent over time, reliability was proven through peer review, member checking and triangulation of interviews, observations and field notes (Lubbe, 2009; Rheeder, et al., 2017).

The Implementation of Neurodevelopmental Supportive Care (INDeSC) Checklists were scored according to the following checklist scales:

- 4 - All the criteria for a certain item are met and is deemed to be highly relevant to the criteria
- 3 - Most of the requirements are met, but there is room for improvement and it is quite relevant
- 2 - Very little few criteria are met and it is somewhat relevant

- 1 - No criteria are met

The mode and the number of observations for each item were presented. The total percentage of observations within the scales for each score of 1, 2/3 and 4 per item were also included in the results.

3.5.3 Infant Sensory Profile™ 2 (ISP 2)

The Infant Sensory Profile™ 2 (ISP 2) is a parent-report questionnaire specifically looking at modulation in preterm infants (Appendix D). Research shows that infants' specific ages had an important effect on the previous Infant Toddler Sensory Prolife, this was due to parents of infants, younger than six to 24 months, having difficulty reporting on behaviours as described. Thus, the ISP 2 was developed by Dunn and her team, with a smaller set of behaviours used in the age group under six months (Dunn, 2014). The ISP 2 consisted of 36 items to accurately identify differences in behaviours between infants and toddlers (Dunn, 2005). The ISP 2 is completed by the parent/caregiver of the infant at their corrected age.

The ISP 2 consists of items divided into sections for sensory systems, including general processing, auditory processing, visual processing, tactile processing, movement processing and oral sensory processing. Each questionnaire contains statements about how the infant might respond to a sensory event in everyday life, and the parent or caregiver records how frequently that behaviour occurs with a 5-point Likert-type scale using never, seldom, occasionally, frequently, and always. Raw scores can be collected from the ISP 2 by adding up the total raw score for each section. These scores are then interpreted according to the 5-point scale, which indicates occasionally as typical development (*like majority*) in the centre, never and seldom represent probable difference (*less than others*) and definite difference (*much less than*) indicating under responsivity, frequently and always represent probable difference (*more than others*) and definite difference (*much more than others*) indicating over responsivity (Dunn, 2014).

Scores for items in each section are also recorded for each type of sensory behavioural response, according to the quadrants described by Dunn, for each infant to determine their sensory threshold and whether they use active or passive self-regulation (Dunn, 1997). The ISP 2 does provide cut off scores for interpretation of the type of sensory modulation and quadrant scores but does not provide norms for comparison to a sample of typical children. The assessment is meant as a guide to the possible presence of SMD and allows follow-up of those identified with a problem. This is due to validity and reliability issues when assessing sensory processing in infants (Dunn, 2014).

In 2012 to 2013, a stratified sample was collected for the ISP 2, where 1791 children were evaluated. The test has established reliability for the caregiver questionnaire (0.83 to 0.97) on the test-retest reliability and inter-rater reliability. The validity was established using previous Sensory Profiles - Vineland-II and School Function Assessment and SP 2 School form (Dunn, 2014).

3.5.4 Bayley Scale of Infant Development – 3rd Edition® (Bayley-III)

The Bayley Scale of Infant Development, 3rd Edition®, identifies infants with developmental delay (Appendix E). The Bayley-III is a norm-referenced test that examines children from 0-46 months of age. The tool consists of five subscales:

- Cognition Scale (91 items)
- Language Scale (97 items)
    - Receptive
    - Expressive
- Motor Scale (138 items)
    - Fine
    - Gross
- Social–emotional Scale (35 items)
- Adaptive Behavioural Scale (241 items)

The Bayley-III is completed in a time frame of 30 to 90 minutes. Infants who score low are at risk for future developmental problems (Bayley, 2007). The Bayley-III has established reliability (0.86 to 0.93); reliability coefficients indicate that the Bayley-III is reliable for children with clinical diagnoses, such as developmental delay or pervasive developmental disorders and/or risk factors in the general population (May-Benson, et al., 2009). Convergent and divergent validity has been established for the Bayley-III (Bayley, 2007). This assessment has been validated for South African infants (Rademeyer, 2013).

The raw scores and the scaled scores were calculated for the cognitive, social-emotional scale and the two combined language and motor scales as well as the four components of the adaptive behaviour sale. These scores were further calculated into composite scores and z scores (Bayley, 2007).

3.6 Research procedure

3.6.1 Phase 1: Situational analysis of the Neonatal High Care Unit and assessment of the infants' sensory modulation

Part 1: Cohort Intake and Situational Analysis of the NHCU

The parents of infants admitted to the NHCU, who met the inclusion criteria (<37 weeks gestational age), were approached in the NHCU. They were invited to participate in the study and if they agreed, they were asked to sign informed consent (Appendix G) and to complete the demographic questionnaire (Appendix A). Data from the infants' medical files were recorded by the researcher (Appendix B). The collection of data on the demographic factors of the infants provided the researcher with comprehensive background information of the infants in the NHCU.

The INDeSC checklist (Appendix C) was used to conduct the situational analysis, which allowed for a structured observation as to what the NHCU environment encompasses. This checklist was completed during daytime, twice a week for six months on different days and times, while the infants who had been recruited into the study, were in the NHCU. The environment of the NHCU was thus recorded 48 times in order to obtain accurate and reliable information about the overall impression of the NHCU environment and to determine what factors in this environment, outlined on the INDeSC checklist, were adhered to and which items were not observed or addressed. The researcher observed the NHCU environment and care of the infants (participants only) for 60 minutes at a time. The researcher walked around the NHCU quietly when observing. All eight incubators were visible during this time due to the compact size of the NHCU.

Part 2: Assessing the premature infants 4 weeks post discharge

The assessment of the infants' sensory modulation took place at their follow-up appointment, 4 weeks post discharge, using parent reports on the ISP 2. The premature infants' parents were asked to fill out the ISP 2 at Edenvale General

Hospital in the paediatric ward at the neonate clinic. The researcher was there to hand out and collect the questionnaires. For parents/caregivers who were illiterate, the researcher read out the questions and scribed for them; for parents/caregivers who struggled with English as their first language, the nurses at the clinic assisted both them and the researcher.

The INDeSC and the ISP 2 presented with different headings so it could not be assumed that all the categories such as Handling Techniques or Environment Adaptations on the INDeSC checklist related to all the sensory system processing on the ISP 2. Therefore, before possible links between the NHCU environment and the sensory profile could be described, a study to align the variables was completed. Two expert occupational therapists, with PhD and MSc degrees respectively, South African Institute of Sensory Integration (SAISI) lecturing experience and more than 10 years' experience in Sensory Integration practice, were asked to analyse the categories on the INDeSC checklist in relation to the type of sensory processing each item represented. After the experts' consent to participate in the study was obtained (Appendix K), they were provided with the INDeSC (Lubbe, 2009) and descriptions of each sensory system on the ISP 2 manual (Dunn, 2014). The sensory system that may be affected by each item in the nine categories of the INDeSC checklist was confirmed, any differences were discussed, and agreement was achieved on all items between the experts (Appendix L).

3.6.2 Phase 2: Sensory modulation and normal development at 3-6 months (corrected age)

The infants were followed up again at the age of 3-6 months (corrected age) at Edenvale General Hospital in the Occupational Therapy Department. Appointments were made with all the parents and they were asked to complete the ISP 2 on their infants again. The researcher completed the Bayley-III on each infant who attended this appointment; the parent/caregiver was present when the Bayley-III was administered. The Social-emotional and Adaptive Behaviour section of the Bayley-III was completed by the parents of the infants. This evaluation took approximately 30 to 90 minutes to complete, dependent upon each participant.

3.7 Data Analysis

All data were entered into Excel spreadsheets and checked for completeness and accuracy. Descriptive statistics, frequencies and percentages described the demographic information of the infants. The Pearson correlation was used to determine if there was an association between the infants' medical demographic factors and their Sensory Profiles. The results of the INDeSC checklist were analysed using descriptive statistics. The mode or score that occurred most often for each category on the INDeSC checklist was calculated, as well as the number of times this category was observed in the 48 observations completed in the NHCU. This provided information of how often a certain environmental factor occurred in the NHCU and whether it was consistently observed as being present, occasionally present or absent in terms of meeting the criteria (1 - no criteria met, 2 and 3 - some criteria and 4 - all criteria met) to support the neurodevelopmental supportive care (NDSC) principles laid out on the checklist.

The ISP 2 data were analysed for Phase 1 and Phase 2 to determine the infants' sensory function using the raw scores which were converted to z scores and analysed according to the normal distribution curve. This allows data to be presented graphically for the frequency with which the infants presented with over responsivity - *much more than others* or *more than others,* typical responsivity - *like majority* and under responsivity - *much less than others* or *less than others.* The frequency or percentage of infants in each quadrant indicating behaviour in response to sensory input was also analysed from the items on the ISP 2. Some items on this profile do not indicate quadrants and these were analysed as no quadrant scores.

In order to determine any link between the frequency of items on the ISP 2 which indicate over responsivity - *much more than others* or *more than others,* typical responsivity - *like majority* and under responsivity - *much less than others* or *less than others* and the frequency with which items on the INDeSC were observed to meet the criteria for NDSC principles in the NHCU, the frequencies were presented together in tables.

All the items for each sensory processing section were analysed for the 22 infants and the percentage of items indicting over responsivity - *much more than others* or *more than others,* typical responsivity - *like majority* and under responsivity - *much* *less than others* or *less than others* were presented. All the categories from the INDeSC which experts had indicated were linked to each sensory processing section, were presented in the same table. The mean percentage scores according to the criteria (1 - no criteria met, 2 and 3 - some criteria and 4 - all criteria met) for the items linked to the category were presented under each category to provide an indication of the criteria met linked to that specific sensory system.

Items in each of the categories with a score of 1 in at least 80% of observations were then also listed to give an indication of which criteria not met in the NHCU might be linked to the sensory processing frequencies in each sensory system.

The Bayley-III has an ordinal scale, which was converted into scaled scores, composite scores and z scores, or interval data, to identify if infants had developmental delay. This data was presented descriptively with means of the composite scores as well as graphically using z scores to identify areas of delay in the various skills assessed by the Bayley-III.

The data from the ISP 2 in terms of type and level of SMD and the developmental delay assessed on the Bayley III were presented for each infant in a table. The data were not analysed further except to provide the main composite score of the motor, cognitive and language as assessed by the therapist and the mean composite scores for social-emotional behaviour and adaptive behaviour as assessed by the parents.

3.9 Ethical Considerations

Ethical clearance was obtained from the University of the Witwatersrand's Human Research Ethics Committee (M150904 - Appendix F). Permission was obtained from the Hospital CEO (Appendix H), Head of the NHCU and (Appendix I) Head of Occupational Therapy Department at Edenvale General Hospital (Appendix J) to allow the researcher to use the hospital's facilities. The staff of the NHCU was informed of the study by the Head of the NHCU.

The parents were given an information sheet, informing them of the research process, and asked to sign the informed consent to participate in the study and allow their child to be assessed (Appendix G). The participants of the study, i.e., the infants and parents/caregivers, were the first consideration of the researcher, as the researcher at all times of the study placed the participants' interests first. If ill or unable to participate in the study, the participant was not forced and was given the option to be removed from the study. Participation in the study was voluntary and parents/caregivers were informed they could withdraw at any time. All parents/caregivers were informed that refusal to participate and withdrawal from the study at any time, would have no consequences and would not affect their child's therapy in any way. The two SI experts were also invited to participate in the study.

Precautions were taken to protect the privacy and confidentiality of the participant's information by not using the participants' names in the study. For example, their names did not appear on their ISP 2 or the Bayley-III forms, and each participant was given a code to allow for confidentiality. A flash stick that was password protected, and locked in a cupboard when not in use, was used to ensure the data was secure. The data collected will be kept for six years on the laptop and flash stick. These measures will ensure that the data is protected if the laptop malfunctions or is stolen within the six-year period.

If sensory modulation or developmental delay deficits were identified, the participant was referred to the appropriate rehabilitation professionals for intervention.

CHAPTER 4: RESULTS

4.1 Introduction

This chapter presents the results of the study including the demographics of the infants, the parents and the medical history of the infants. It contains the results of the Implementation of Neurodevelopmental Supportive Care (INDeSC) checklist describing the Neonatal High Care Unit (NHCU) environment while the infants were in the NHCU. The results of the Infant Sensory Profile™ 2 (ISP 2) of the infants at 4 weeks post discharge and at 3-6 months post discharge, are presented. The infants were also assessed using the Bayley Scales of Infant and Toddler Development, 3rd Edition (Bayley-III) and the developmental outcomes of these infants, at three months post discharge, are presented.

The results chapter further looks at the link between demographics, the environment and the sensory profile of the infants within the NHCU which is descriptively presented. The total number of infants recruited was 22, who were born <37 weeks gestation and admitted to the NHCU. These infants spent at least one week in the NHCU. Of the 22 infants, 10 returned for their follow-up appointments, 55% (n=12) were lost to follow-up.

PHASE 1

4.2 Demographic Information

Demographic information of the infants included their gestational age, birth weight, Apgar score (5 min and 10 min), colour, head circumference, length, temperature and length of stay. It is to be noted that not all demographic information was available, for example, not all Apgar scores were recorded, therefore not all the percentages in Table 4.1 add up to 100% (Table 4.1). Although the Apgar score at 5 and 10 minutes was not available for two of infants, these infants displayed no signs of any neurological deficits and were therefore included in the study.

Amongst those born prematurely, the greatest percentage of infants (63.6%) were between 900-1400 grams, which indicated they fell into the extremely low and very low weight groups for premature infants. At 5 minutes, most infants scored an Apgar of 9 (36%; n=8) and at 10 minutes this had changed to 41% (n=9), with an increase of 36% (n=8) of infants scoring 10. With regard to colouring at birth, 86% (n=19) of the infants were pink. The highest number of infants had a length of 38-40cm long (27%, n=6). Seventy-seven percent (n=17) of the infants' temperature was between 36°C and 36.9°C. The length of stay in the NHCU for most infants (77%; n=17) was between 1-6 weeks with 9% (n=2) of infants being admitted for longer than 13 weeks.

Fifty percent (n=11) of the mothers were pregnant for 32-34 weeks; a further 18% (n=4) and 23% (n=5) of mothers were respectively pregnant for 30-31 weeks and 28-29 weeks. The majority of the mothers (n=20, 91%) had a grade 12 level of education or a tertiary qualification.

Table 4.1: Demographic information of the infants (n=22)

Infants gestational age	**24-25**	**26-27**	**28-29**	**30-31**	**32-34**
	4.54% (n=1)	4.54% (n=1)	22.7% (n=5)	18.18% (n=4)	50.00% (n=11)
Weight (grams)	**900 - 1100**	**1101 - 1400**	**1401 - 1600**	**1601 - 1800**	**>1801**
	27.27% (n=6)	36.36% (n=8)	13.63% (n=3)	13.63% (n=3)	9.09% (n=2)
Apgar score 5 min	**6**	**7**	**8**	**9**	**10**
	9.09% (n=2)	18.14% (n=4)	27.27% (n=6)	36.36% (n=8)	0.00% (n=0)
Apgar score 10 min	**6**	**7**	**8**	**9**	**10**
	0.00% (n=0)	4.54% (n=1)	9.09% (n=2)	40.90% (n=9)	36.36% (n=8)
Colour	**Pink**	**Yellow**	**Blue**		
	86.36%(n=19)	4.54% (n=1)	9.09%(n=2)		
Head Circumference (cm)	**25-28**	**29-32**	**33-36**	**37-40**	**41-44**
	27.27% (n=6)	45.45% (n=10)	4.54% (n=1)	0.00% (n=0)	0.00% (n=0)
Length (cm)	**32-34**	**35-37**	**38-40**	**41-43**	**44-46**
	13.63% (n=3)	22.72% (n=5)	27.27% (n=6)	13.63% (n=3)	0.00% (n=0)
Temperature (°C)	**34.0 – 34.9**	**35.0 – 35.9**	**36.0 – 36.9**	**37.0 – 37.9**	
	4.54% (n=1)	9.09% (n=2)	77.27% (n=17)	4.54% (n=1)	
Length of stay in NHCU (weeks)	**1-3**	**4-6**	**7-9**	**10-12**	**13-15**
	40.90% (9)	36.36% (8)	4.54% (1)	9.09% (2)	9.09% (2)

4.3 Neonatal High Care Unit Environmental Factors

In this study, the INDeSC checklist, which consists of nine categories with various items under each category, was used to determine the environmental factors. The NHCU was assessed 48 times over the research period, which was twice a week for six months. A mode of the scores over that time is presented in Tables 4.2 - 4.10 below as well as the number of times or frequency of the mode for each particular category observed. Not all items were observed on each NHCU visit and therefore the frequency of the criteria all met, sometimes met and not met, are presented based on the number of observations for each item.

4.3.1 Neonatal Intensive Care Design

The NICU Design category of the INDeSC consists of one item related to the uterine-like environment, which needs to be created for each infant. This category had a mode of 1, with this principle of the Neurodevelopmental Supportive Care (INDeSC) checklist not being observed more than 50% of the time indicating the NHCU did not simulate a uterine-like environment. There were no observations during which all the criteria were met (score of 4) (Table 4.2).

Table 4.2: Neonatal High Care Design

Neonatal Intensive Care Design	Mode	No of obs	% observation scores		
			1 No criteria met	2 and 3 Some criteria met	4 All criteria met
Is a uterine-like environment is created to support an environment conducive to growth and optimum development	1	48	52.00	48.00	0.00

4.3.2. Individualised Care

The Individualised Care category of the INDeSC consists of two subcategories related to Observations and Care provided by staff and caregivers in the NHCU and six items. More than 85% of the observations for all items in this category indicated a score of 1 "no criteria met". This indicates the individualised care principles on the INDeSC were not applied in the NHCU (Table 4.3).

Table 4.3: Individualised Care

Individualised Care		Mode	No of obs	% observation scores		
				1 No criteria met	2 and 3 Some criteria met	4 All criteria met
Observation	The caregiver reads the infant's cues and behaviours	1	41	85.37	14.63	0.00
	The staff responds to infant cues and behaviours	1	45	93.34	2.22	4.44
	The caregiver continuously and systematically assesses and evaluate the infant's developmental needs	1	48	100.00	0.00	0.00
	Care is adapted according to cues and behaviours	1	45	93.34	2.22	4.44
Care	Care is provided according to the infant's individual developmental maturity	1	48	100.00	0.00	0.00
	Autonomic, motoric, and behavioural cues are identified and used to support individualised caregiving	1	48	100.00	0.00	0.00

4.3.3 Family-Centred Philosophy

The Family-Centred Philosophy category of the INDeSC includes four subcategories and 13 items. The four subcategories are Parents as Active Participants, Privacy and Comfort, Visitation and Parent Support Groups. Of the 13 items, five had a mode of 1, indicating the INDeSC principles related to these items were not applied in the NHCU (Table 4.4). Six items had a mode of 4, indicating sufficient application of the INDeSC principles and two items scored a 2 and a 3, indicating that the NDSC principles were somewhat met within the NHCU.

In the first subcategory with seven items, criteria were met in between 76% to 98% for all items with the exception of “Parents hold their infants” and “Discharge training commenced”. In the subcategory Privacy and Comfort the nursery atmosphere was observed to be somewhat comfortable and soothing 75% of the time while 96% of observations indicated no privacy is provided for the parents. Criteria on Professionals sharing information with parents on their infant's developmental needs were not met 66% of the observations. In the Visitation subcategory parents visiting at any time were observed 97% of the time although siblings were never allowed to visit and in the subcategory Parent Support Groups no parent support groups were observed.

Table 4.4: Family Centred Philosophy

Family Centred Philosophy		Mode	No of obs	% observation scores		
				1 No criteria met	2 and 3 Some criteria met	4 All criteria met
Parents as Active Participants	Parents see their infant immediately after birth	4	46	0.00	4.34	95.66
	Parents touch their infant immediately after birth	4	46	0.00	4.34	95.66
	Parents hold their infant	3	32	0.00	65.53	34.37
	Parents are involved with care, e.g., feeding, bath, KMC.	4	40	17.50	0.00	82.50
	Parents are allowed to personalise their infant's bed space	4	37	18.91	5.40	75.69
	Mothers are encouraged to express milk for their infant, or to breastfeed.	4	47	2.13	0.00	97.87
	Discharge training commenced	1	47	97.87	2.13	0.00
Privacy and comfort	Nursery atmosphere is warm, comfortable and soothing with a homelike appearance	2	34	22.93	75.04	2.08
	Privacy is provided for parents	1	46	95.83	4.17	0.00
	Information is shared between professionals and parents regarding their infant's developmental needs.	1	32	65.62	3.13	31.25
Visitation	Parents are allowed to visit at any time	4	37	0.00	2.70	97.30
	Siblings may visit	1	48	100.00	0.00	0.00
Parent support groups	The facility has parent support groups	1	48	100.00	0.00	0.00

4.3.4 Positioning

The Positioning category of the INDeSC consists of six subcategories related to the Anatomical Position of Infants, Containment, Midline, Flexion, Orientation, and Individualised Bedding, and 12 items (Table 4.5).

Table 4.5: Positioning

Positioning		Mode	No of obs	% observation scores		
				1 No criteria met	2 and 3 Some criteria met	4 All criteria met
Anatomical infant positioning	Infants are positioned anatomically with the neck in a neutral position, shoulders protracted, body symmetric, knees flexed with hips and arms in midline. This state is reached with the use of containment and firm boundaries	1	37	78.38	16.22	5.40
Containment	The infants are contained	4	34	22.24	6.92	70.82
	The infants have firm boundaries that fit snugly	1	35	72.95	0.00	27.05
Midline	The body position is symmetric	1	40	83.30	6.25	10.45
	The neck is in neutral position with the head in midline in line with the body.	1	40	83.30	6.25	10.45
	The shoulders are protracted	1	40	83.30	6.25	10.45
	The arms are in midline	1	38	79.22	6.20	14.58
Flexion	The knees are flexed	4	36	16.66	8.33	75.01
	The hips are flexed in a neutral position with some adduction	1	37	78.39	16.21	5.40
	Infant is kept in flexion (limbs and shoulders) during positioning and postural support.	1	39	79.50	15.38	5.12
Orientation	Prone or side-lying positions are rather used than supine, especially in acutely ill infants	1	41	85.38	9.75	4.87
Individualised bedding	Individualised bedding is used to position infants.	4	38	15.78	5.26	78.96

Of these 12 items, three items had a mode of 4, “the infants are contained” in the Containment subcategory, “knees are flexed” in the Flexion subcategory and “individualised bedding is used to position infants” in the Individualised Bedding subcategory indicating sufficient application of the NDSC principles related to positioning. Between 71%-79% of the observations made for these items were scored a 4.

The other nine items in the Positioning category had a mode of 1, indicating the NDSC principles were not applied in the NHCU and they did not meet the criteria in the INDeSC between 73% and 85% of the time when observed.

4.3.5 Handling Techniques

The Handling Techniques category of the INDeSC consists of 19 items related to the seven subcategories: Care according to Maturation, The State Changes, Promotion of Rest and Sleep, Modified Hands-on Care-giving, Positive Tactile Stimulation, Movement and Self-regulation. Of these 19 items, 15 items had a mode of 1, indicating the NDSC principles are not applied in the NHCU, and they did not meet the criteria in the INDeSC between 70% and 100% of the time when observed. One item in the Modified Hands-on Care-giving subcategory met no criteria in the INDeSC, 50% of the time.

Three items had a mode of 4 indicating sufficient application of the NDSC principles related to handling of the preterm infant in the NHCU. These items included: “Parents are allowed to do skin-to skin care with their infants” in the Positive Tactile Stimulation subcategory and “Appropriate soft bedding is used” and “Multiples are co-bedded” in the Movement subcategory. Between 63%- 94% of the observation made for these items were scored a 4 (Table 4.6).

Table 4.6: Handling Techniques

Handling Techniques (Transition Support)		Mode	No of obs	% observation scores		
				1 No criteria met	2 and 3 Some criteria met	4 All criteria met
Care according to	Care changes as infants matures	1	43	87.28	10.40	2.32
The State Changes	State changes: The caregiver supports gradual state changes by using transitional touch	1	39	81.50	14.34	4.16
Promotion of rest and sleep:	The infants receive at least 23 hours uninterrupted sleep. The unit has quiet times where all routine cares and interventions are delayed	1	45	100.00	0.00	0.00
	The unit has quiet times where all routine cares and interventions are delayed.	1	48	93.75	2.09	4.16
Modified Hands-on Care-giving	Care interventions are clustered around sleep.	1	47	97.88	0.00	2.12
	Calm, gentle containment and facilitation is provided during handling procedures to support flexion	1	34	70.60	29.40	8.82
	The infant is provided with "time-out" or rest periods according to his/her cues	1	47	97.88	0.00	2.12
	Direct hands-on-caregiving is modified by providing positive tactile stimulation	2	24	41.61	50	8.39
Positive tactile stimulation	Positive tactile stimulation is provided, including stroking or gentle massage if applicable	1	37	83.59	13.53	2.88
	Containment or still hold is provided	1	34	70.01	26.66	3.33
	Parents are allowed to do skin-to skin care with their infants within 24-48 hours (2), after 48 hours (1) never or no proof of skin-to-skin (0)	4	30	33.33	3.33	63.34
	Preterm infants are swaddled	1	46	95.56	4.44	0.00
Movement	Preterm infants are moved slowly, as a whole, keeping the body and head aligned and limbs tucked in	1	41	84.94	5.31	9.75
	Appropriate soft bedding is used	4	45	6.25	0.00	93.75
	Multiples are co-bedded. Always (2) if stable (1) never (0)	4	30	33.33	3.33	63.34
Self-regulation	Self-regulation of infants is promoted	1	48	100.00	0.00	0.00
	Infants are provided with opportunities for grasping	1	47	97.91	2.09	0.00
	State regulation is promoted	1	48	100.00	0.00	0.00
	Non-nutritive sucking is provided to support self-regulation	1	47	97.91	2.09	0.00

4.3.6 Environmental Manipulation

The Environmental Manipulation category has three subcategories, Noise, Light and Olfactory stimulation, which consist of 32 items (Table 4.7a and 4.7b).

- Noise environmental manipulation: on the INDeSC, this subcategory consists of 17 items related to three sections: Reduction of noise, Immediate infant environment and Staff generated noise kept to a minimum.

Table 4.7a: Environmental Manipulation (Noise)

Environmental manipulation		Mode	No of obs	% observation scores		
Noise				1 No criteria met	2 and 3 Some criteria met	4 All criteria met
Reduction of noise	No radio or stereo equipment used in the unit, telephones away and rings softly	1	33	68.75	27.08	4.17
	Doors and drawers are padded to reduce noise	1	42	87.50	8.33	4.17
	Bottoms of trash cans are padded/lids with peddle bins padded	4	46	2.09	2.09	95.82
	Sound levels are measured and kept below 45dB	1	28	58.33	39.58	2.09
	Soft music is used where appropriate	1	48	100.00	0.00	0.00
	Infant beds are placed away from traffic	1	48	100.00	0.00	0.00
	There is effective sound absorption in infant spaces, e.g. curtains, wall hangings or padding	1	48	100.00	0.00	0.00
	Monitor alarms are kept at a safe minimum volume or set to vibrate/flashing	1	32	66.66	29.17	4.17
	Staff respond to alarms quickly	1	45	93.75	2.08	4.17
Immediate infant environment	Noise reduction incubator covers are used	1	48	100.00	0.00	0.00
	Soft ear plugs or covers are used	1	48	100.00	0.00	0.00
	Closed incubator portholes are closed quietly by using the latch	4	42	12.50	0.00	87.50
	Sound levels are measured in the incubator	1	48	100.00	0.00	0.00
	Ventilator tubes are emptied regularly, no water build-up	4	47	2.08	0.00	97.92
	Minimal background noise at the infant	1	36	75.00	20.83	4.17
Staff generated noise kept to a minimum	Charts and stock items are placed next to incubators, not on top	4	46	4.17	0.00	95.83
	Staff keep their voices down and away from the infant's bedside	1	39	81.25	16.66	2.09

- Light Environmental Manipulation**:** this subcategory has 14 items, which considers Reduction of Light, Immediate infant bed space and Cycled light.
- Olfactory stimulation: has one item related to positive smell.

Table 4.7b: Environmental Manipulation (Light and Olfactory)

		Mode	No of obs	% observation scores		
Light				1 No criteria met	2 and 3 Some criteria met	4 All criteria met
Reduction of light	Ambient light is reduced/dimmed	1	48	100.00	0.00	0.00
	Blinds are closed during daylight hours	1	37	77.08	22.92	0.00
	Activity levels are kept as low as possible	1	32	66.67	29.16	4.17
Immediate infant bed space:	Incubator covers are used with closed incubators	1	48	100.00	0.00	0.00
	Direct bright light is avoided	1	48	100.00	0.00	0.00
	Bedside lights are titrated/controlled	1	48	100.00	0.00	0.00
	Light levels inside incubators are measured	1	46	95.83	0.00	4.17
	Eye protection is used with phototherapy	4	30	37.50	0.00	62.50
	One source of daylight is used with a shading device	1	48	100.00	0.00	0.00
	Overhead lights are dimmed	1	47	97.92	2.08	0.00
	Procedures are kept to a minimum to ensure minimum handling	1	30	62.50	18.75	18.75
	Toys, pictures and appropriate music used to reduce sensory monotony	1	43	89.58	0.00	10.42
Cycled light:	The unit provides cycled light	1	48	100.00	0.00	0.00
	Day/night cycle is provided with 12 hours of low light and sound at night	1	47	97.92	2.08	0.00
Olfactory						
Olfactory stimulation	Positive olfactory stimulation is provided, such as mom's smell inside the incubator.	1	45	93.75	0.00	6.25

Of the 32 items for Environmental Manipulation, 27 had a mode of 1, indicating these principles are not applied in the NHCU. Out of the 27 items, 12 items did not comply with the INDeSC criteria, 100% of the time. These included six items in the Noise subcategory, four items in the Immediate infant bed space section and one item in the cycled light section.

Five of the 32 items had a mode of 4, indicating sufficient application of the NDSC principles related to the environment within the NHCU. These items met all the criteria in the INDeSC between 63%-100% of the time when observed.

4.3.7 Pain Management: Non-pharmaceutical Pain Reduction

The Pain Management category of the INDeSC consists of two items related to nonpharmaceutical pain reduction strategies. Both items had a mode of 1 indicating these pain management principles are not applied in the NHCU; they did not meet the criteria in the INDeSC 98% - 100% of the time when observed. (Table 4.8).

Table 4.8: Pain management: Non-pharmaceutical Pain Reduction

Pain Management		**Mode**	**No of obs**	**% observation scores**		
				1 No criteria met	2 and 3 Some criteria met	4 All criteria met
Non-pharmaceutical pain reduction	Oral glucose is effectively and correctly administered as pain management option	1	48	100.00	0.00	0.00
	Non-nutritive sucking is provided during painful minor procedures	1	48	97.92	2.08	0.00

4.3.8 Knowledge of Infant Development

The Knowledge of Infant Development consists of two subcategories: Knowledge of Infant Development and Parental Education. The Knowledge of Infant subcategory considers the knowledge and training of staff and the teamwork between them. Of these three items, one item “Staff attended training and are able to read infant cues and behaviours” had a mode of 1 indicating these principles were not applied in the NHCU as these criteria were not observed 98% of the time. Two items in the Knowledge of infant development subcategory had a mode of 4, indicating sufficient application of the NDSC principles related to this subcategory within the NHCU.

In the Parental education subcategory, both items scored a mode of 1, “Parents are taught preterm infant behavioural cues and stress signs” and “Parents are taught how to interact with their preterm infant based on the cues and behaviours”, indicating that these criteria were not observed 98%-100% of the time (Table 4.9).

Table 4.9: The Knowledge of Infant Development

		Mode	No of obs	% observation scores		
				1 No criteria met	2 and 3 Some criteria met	4 All criteria met
Knowledge of Infant Development	Staff attended training and are able to read infant cues and behaviours	1	48	97.92	2.08	0.00
	Knowledge is shared between professionals	4	41	14.58	0.00	85.42
	The unit applies a multidisciplinary team approach	4	45	4.44	2.22	93.34
Parental education	Parents are taught preterm infant behavioural cues and stress signs	1	48	100.00	0.00	0.00
	Parents are taught how to interact with their preterm infant based on the cues and behaviours	1	48	97.92	2.08	0.00

4.3.9 Feeding

The Feeding category of the INDeSC consists of three items related to the preparation of the infant for feeding. All three items had a mode of 1, indicating these principles are not applied in the NHCU, as they did not meet the criteria in the INDeSC approximately 98%-100% of the time when observed (Table 4.10).

Table 4.10: Feeding

Feeding	**Mode**	**No of obs**	**% observation scores**		
			1 No criteria met	2 and 3 Some criteria met	4 All criteria met
Preterm infants are prepared for feeding	1	43	100.00	0.00	0.00
Preterm infants are positioned in a way that prevents the need for repositioning after a gavage feed	1	48	97.92	2.08	0.00
Non-nutritive sucking is provided during gavage feeding	1	47	100.00	0.00	0.00

In summary, the INDeSC consists of nine categories. Although there were some individual items within the nine NDSC categories with a mode of 2, 3 or 4, majority of the items had a mode of 1 which indicates majority of the NDSC principles are not applied in the NHCU.

4.4 The Infant Sensory Profile™ 2 (ISP 2) – 4 weeks post discharge

4.4.1 Sensory modulation and quadrants

The total score on the Infant Sensory Profile™ 2 (ISP 2) was analysed according to the normal distribution curve to classify the infant's sensory modulation according to five categories. These categories include – *much less than others* (-2 standard deviations below the normal curve), *less than others* (-1 standard deviation below the normal curve), *just like the majority of others* (0 standard deviations), *more than others* (+1 standard deviation above the normal curve) and *much more than others* (+2 standard deviations above the normal curve). It is important to note in the context of the ISP 2, +1 (*more than others*) and +2 (*much more than others*) refer to disfunction as discussed in the literature review (page 25). The frequency of infants for each of the quadrant scores were based on a 5-point scale from almost always, frequently, half the time, occasionally and almost never, which are analysed according to the four quadrants (seeking, avoiding, sensitivity and registration).

4.4.1.1 Sensory modulation at 4 weeks post discharge

Just under 60% (n=13) of the infants were found to have sensory profiles indicating sensory modulation, which was *much more than others* indicating over responsivity, and 5% (n=1) of the infants presented with modulation that was *more than others*. Only 28% (n=6) of the infants presented with sensory modulation that fell into the normal range, *like majority* and 9% (n=2) having modulation that was *much less than others* infants indicating under responsivity (Figure 4.1).

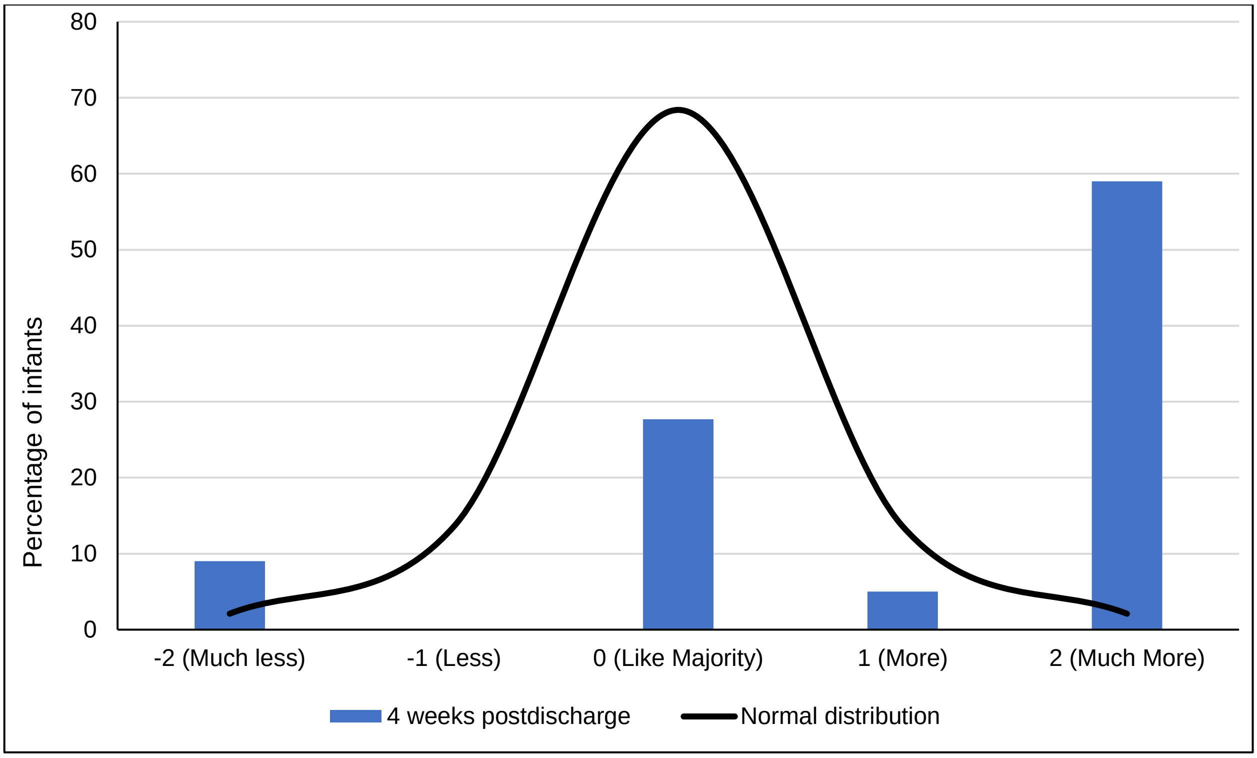

Figure 4.1 Percentage of infants scoring in the categories of sensory modulation on the Infant Sensory Profile™ 2 at 4 weeks post discharge (n=22)

4.4.2 Quadrant Scores

4.4.2.1 Quadrant scores at 4 weeks post discharge

The percentage of infants in each range of the scores on the quadrants, from almost always to almost never, for the total group at 4 weeks post discharge, indicated sensitivity towards stimuli was almost always or frequently reported for half the infants (n=11) related to the sensitivity quadrant, with a low threshold and passive self-regulation (Dunn, 2014). Over a third of the infants (36%; n=8) presented with avoiding behaviour almost always or frequently, indicating a low sensory threshold and active self-regulation. Seeking behaviour, indicating a high threshold and active self-regulation, occurred only occasionally or almost never in 82% (n=18) of the infants. Behaviour in quadrants related to registration and seeking, which are associated with a high threshold and under responsivity, were seen less often than behaviours related to sensitivity and avoiding associated with a low threshold and over responsiveness (Figure 4.2).

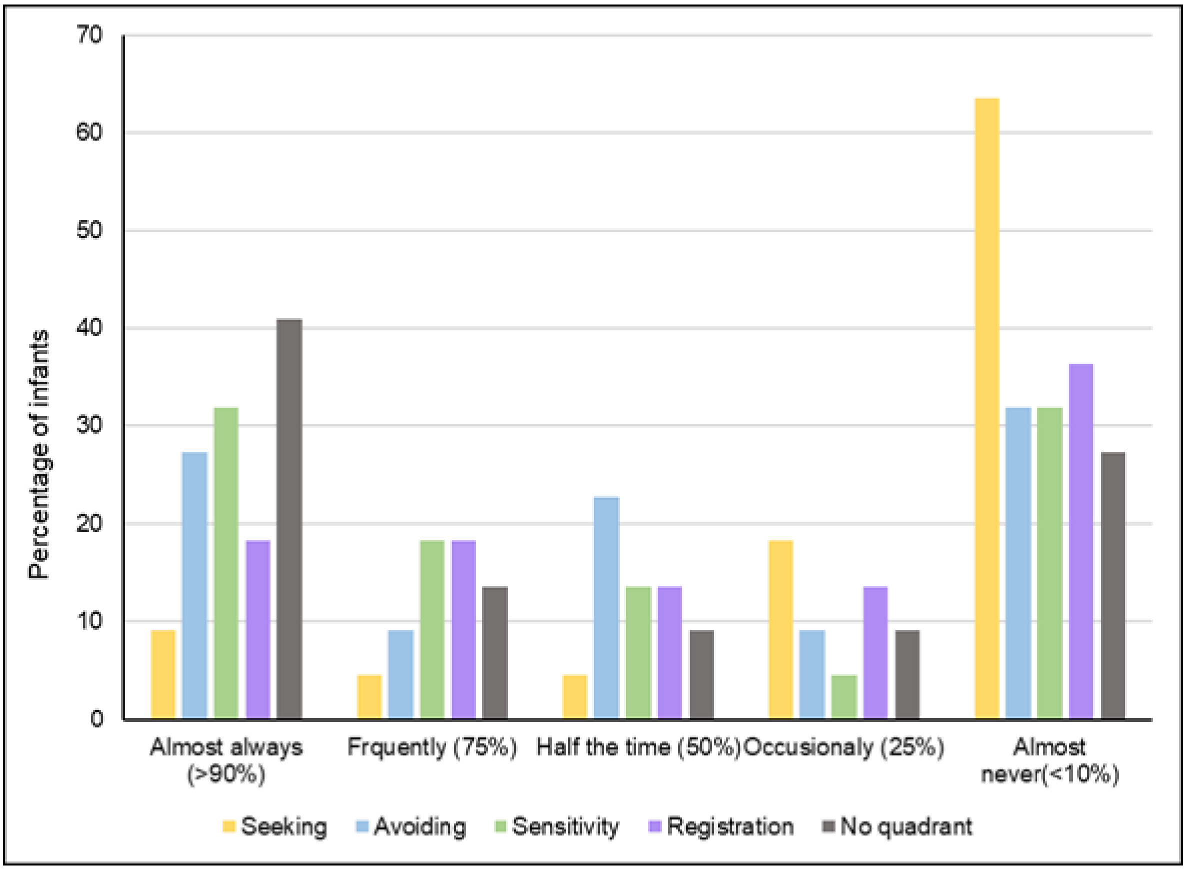

Figure 4.2 Percentage of infants in the range of scores in each quadrant on the Infant Sensory Profile™ 2 at 4 weeks post discharge (n=22)

4.5 Demographics, the neonatal high care environment and the sensory profile

4.5.1 Association between the medical demographics and the Infant Sensory Profile™ 2

The demographic factors that were not nominal and could be correlated included the medical factors of the infants. These, were analysed in relation to the scores on the sensory profile at 4 weeks post discharge. No correlation was found except for a low correlation to head circumference with a coefficient of determination (r^2) indicting 4.4% of the variance in the sensory profile scores are predictable from the head circumference (Table 4.11).

Table 4.11 Correlation between medical demographic factors and Infant Sensory Profile™ 2 scores

Demographic factors	Sensory Profile	
	r	r^2
Gestation period	-0.040	-0.001
Weight (grams)	0.030	0.000
Apgar 5 minutes	-0.110	0.012
Apgar 10 minutes	-0.080	0.006
Head circumference (cm)	0.210	0.044
Length of time in NICU	0.030	0.000

4.5.2 The adherence of criteria met in the neonatal high care environment and the outcomes for types of sensory systems on the Infant Sensory Profile™ 2

The types of sensory processing on the ISP 2 were analysed for the number of items that scored a definite and probable difference, more or less than others and typical and these were reflected descriptively as a percentage for each type of sensory processing. Under each type of sensory modulation, the mean percentage adherence to criteria on the INDeSC categories, which experts indicated may be linked to that specific type of sensory processing in NHCU, are also listed. Items for each category on the INDeSC checklist for which *No criteria were met (score of 1)* 80%-100% of the time, are presented in the results as an indication of the factors in the NHCU which may be linked to sensory modulation dysfunction.

4.5.2.1 General Processing

The General Processing items measure the child's responses related to routines and schedules (Dunn, 2014). The percentage of the eight items for General Processing for the 22 infants on the ISP 2, on which infants scored a definite and probable difference, more or less than others and typical, was established. A higher percent of items on the ISP 2 were scored as *much more than others* (50%) than *much less than others* (14%) for infants for General Processing. These are represented in Table 4.12 with the percentage of the criteria met in the categories on the INDeSC checklist linked by the experts to General Processing (Appendix L).

Table 4.12 Percentage of items on the Infant Sensory Profile™ 2 reflecting sensory processing levels (more and less than others) and the percentage criteria and items for categories on the INDeSC linked to General Processing

Type of sensory modulation		Mean percentage criteria score for all categories on the INDeSC linked to general processing		Items in category with No criteria met score 80% of the time and over
			%	
General Processing - items %		**Neonatal High Care Design**		
Definite difference - Much more	50.07	1 No criteria met	52.00	
		2 and 3 Some criteria met	48.00	
		4 All criteria met	0	
		Individualised care		
		1 No criteria met	89.17	The staff responds to infant cues and behaviours
		2 and 3 Some criteria met	10.00	Care is adapted according to cues and behaviours. Care is provided according to the infant's individual developmental maturity
Probable difference- More	11.93	4 All criteria met	0.83	Autonomic, motoric, and behavioural cues are identified and used to support individualised caregiving.
		Family Centred Philosophy		
		1 No criteria met	40.83	Discharge training commenced
		2 and 3 Some criteria met	22.91	
		4 All criteria met	36.25	
Typical	**13.06**	**Positioning**		
		1 No criteria met	62.76	The body position is symmetric
		2 and 3 Some criteria met	12.34	The neck is in neutral position with the head in midline in line with the body. The shoulders are protracted
		4 All criteria met	24.90	Prone or side-lying positions are rather used than supine, especially in acutely ill infants
		Handling Techniques		
		1 No criteria met	82.08	Care changes as infants matures. The care giver supports gradual state changes by using transitional touch. The unit has quiet times where all routine care and interventions are delayed.
		2 and 3 Some criteria met	6.94	Care interventions are clustered around sleep. The infant is provided with "time-out" or rest periods according to his/her cues Preterm infants are swaddled. Preterm infants are moved slowly, as a whole, keeping the body and head aligned and limbs tucked in. Self-regulation of infants is promoted.
Probable difference- Less	10.74	4 All criteria met	10.97	Infants are provided with opportunities for grasping. State regulation is promoted. Non-nutritive sucking is provided to support self-regulation

		Environmental adaptation (manipulation)		
		1 No criteria met	70.25	Doors and drawers are padded to reduce noise
				There are effective sound absorption in infant spaces e.g. curtains, wall hangings or padding.
				Staff respond to alarms quickly
		2 and 3 Some criteria met	10.88	Noise reduction incubator covers are used.
				Sound levels are measured in the incubator
				Staff keep their voices down and away from the infant's bedside
		4 All criteria met	18.87	Incubator covers are used with closed incubators
				Toys, pictures and appropriate music used to reduce sensory monotony
				Day/night cycle is provided with 12 hours of low light and sound at night
		Pain management		
Definite difference - Much less	14.20	1 No criteria met	100.00	Non-nutritive sucking is provided during painful minor procedures
		2 and 3 Some criteria met	0.00	
		4 All criteria met	0.00	
		Knowledge of infant development		
		1 No criteria met	100.00	Parents are taught how to interact with their preterm infant based on the cues and behaviours.
		2 and 3 Some criteria met	0.00	
		4 All criteria met	0.00	
		Feeding		
		1 No criteria met	95.83	Preterm infants are prepared for feeding.
		2 and 3 Some criteria met	1.39	Preterm infants are positioned in a way that prevents the need for repositioning after a gavage feed.
		4 All criteria met	2.78	Non-nutritive sucking is provided during gavage feeding.

The high percentage of item scores (62%) indicating a definite and probable difference for *more than others,* may be linked to the high percentage of NDSC criteria not being met in the NHCU. Under General Processing, this included the linked categories of Individualised care, Family centred philosophy, Positioning, Handling techniques, Environmental adaptation, Pain management, Knowledge of infant development and Feeding on the INDeSC. Items in each category that has a score of 80% or more for not meeting the NDSC principles or a Score of *1 – no criteria met* were identified since the lack of implementation of criteria on these items specifically may link to sensory modulation disorder in General Processing.

A lack of routine was evident under Handling techniques which had the greatest number of items that did not meet NDSC principles 80% of the time. This included very limited quiet times where all routine care and interventions are delayed while care was not clustered around sleep and infants were also not provided with "time-out" or rest periods according to their cues combined with a lack of day/night cycle with 12 hours of low light and sound. Infants were woken up for procedures and handling.

Staff also did not individualise or adapt care to infant autonomic, motoric, and behavioural cues, changing care as the infant matured and parents were not taught how to interact with their preterm infant based on the infants' cues and behaviours. Non-nutritive sucking was rarely provided during painful minor procedures and self-regulation of infants and state regulation was not promoted. Infants were also not prepared and positioned for feeding and had to be repositioned after feeding, again possibly disturbing their sleep routine. Infants were not positioned according to NDSC principles allowing a flexed position and under the Environmental Adaptation category, items related to noise reduction, were not adhered to which again, may have resulted in interrupted sleep.

4.5.2.2 Auditory Processing

The percentage of the four items for Auditory Processing for the 22 infants on the ISP 2, on which infants scored a definite and probable difference, more or less than others and typical, was established. A higher percent of items on the ISP 2 were scored as *much more than others* (51%) than *much less than others* (17%) for infants for Auditory Processing. These are represented in Table 4.13 with the percentage of the criteria met in the categories on the INDeSC checklist linked by the experts to Auditory Processing (Appendix L).

This high percentage of item scores (63%) indicating a definite and probable difference for *more than others* may be linked to the high percentage of NDSC criteria not being met in the NHCU. Under Auditory Processing this included the linked categories of Handling techniques, Environmental adaptation and Feeding on the INDeSC. Items in each category that has a score of 80% or more for not meeting the NDSC principles or a Score of 1 – no criteria met, were identified since the lack of implementation of criteria on these items specifically may link to sensory modulation disorder in auditory processing.

Most items were found under the Environmental adaptation category related to noise reduction. Items that were not adhered to included doors and drawers not being padded little effective sound absorption in infant spaces, staff not responding to alarms quickly, not keeping their voices down near the infants' bedsides and few noise reduction incubator covers being used.

Table 4.13 Percentage of items on the Infant Sensory Profile™ 2 reflecting sensory processing levels (more and less than others) and the percentage criteria and items for categories on the INDeSC linked to auditory processing

<table>
<tr><th colspan="2">Type of sensory modulation</th><th colspan="2">Mean percentage criteria score for all categories on the INDeSC linked to auditory processing</th><th>Items in each category with No criteria met score 80% of the time and over</th></tr>
<tr><td colspan="2"></td><td colspan="2">%</td><td></td></tr>
<tr><td colspan="2">Auditory processing items %</td><td colspan="3">Family centred philosophy</td></tr>
<tr><td rowspan="3">Definite difference - Much more</td><td rowspan="3">51.13</td><td>1 No criteria met</td><td>41.67</td><td></td></tr>
<tr><td>2 and 3 Some criteria met</td><td>16.67</td><td></td></tr>
<tr><td>4 All criteria met</td><td>41.67</td><td></td></tr>
<tr><td rowspan="4">Probable difference-More</td><td rowspan="4">11.36</td><td colspan="3">Handling techniques</td></tr>
<tr><td>1 No criteria met</td><td>74.31</td><td>Care changes as infants matures.</td></tr>
<tr><td rowspan="2">2 and 3 Some criteria met</td><td rowspan="2">4.69</td><td>The unit has quiet times where all routine care and interventions are delayed.</td></tr>
<tr><td>Care interventions are clustered around sleep.</td></tr>
<tr><td rowspan="6">Typical</td><td rowspan="6">11.36</td><td>4 All criteria met</td><td>22.57</td><td>The infant is provided with "time-out" or rest periods according to his/her cues</td></tr>
<tr><td colspan="3">Environmental adaptation (manipulation)</td></tr>
<tr><td rowspan="4">1 No criteria met</td><td rowspan="4">70.50</td><td>Doors and drawers are padded to reduce noise</td></tr>
<tr><td>Soft music is used where appropriate.</td></tr>
<tr><td>Infant beds are placed away from traffic</td></tr>
<tr><td>There are effective sound absorption in infant spaces e.g. curtains. wall hangings or padding.</td></tr>
<tr><td rowspan="6">Probable difference-Less</td><td rowspan="6">9.09</td><td rowspan="4">2 and 3 Some criteria met</td><td rowspan="4">7.78</td><td>Staff respond to alarms quickly</td></tr>
<tr><td>Noise reduction incubator covers are used.</td></tr>
<tr><td>Soft ear plugs or covers are used.</td></tr>
<tr><td>Sound levels are measured in the incubator</td></tr>
<tr><td rowspan="3">4 All criteria met</td><td rowspan="3">21.71</td><td>Staff keep their voices down and away from the infant's bedside</td></tr>
<tr><td>Toys. pictures and appropriate music used to reduce sensory monotony</td></tr>
<tr><td rowspan="5">Definite difference - Much less</td><td rowspan="5">17.04</td><td>Day/night cycle is provided with 12 hours of low light and sound at night</td></tr>
<tr><td colspan="3">Feeding</td></tr>
<tr><td>1 No criteria met</td><td>100.00</td><td rowspan="3">Preterm infants are prepared for feeding.</td></tr>
<tr><td>2 and 3 Some criteria met</td><td>0.00</td></tr>
<tr><td>4 All criteria met</td><td>0.00</td></tr>
</table>

Sound levels were not measured in the incubator, no soft music or ear plugs were provided and no attempt was made to keep the infants away from the traffic in the ward. This may have resulted in exposure to excessive and loud noise during the day and night. The lack of quite times, where all routine care and interventions are delayed, clustering of care around sleep and not providing infants with "time-out" or rest periods meant infants were exposed to noise without long periods of sleep.

4.5.2.3 Visual Processing

The percentage of the four items for the 22 infants for Visual Processing on the ISP 2, which infants scored a definite and probable difference, more or less than others and typical, was established. A higher percent of items on the ISP 2 were scored as *much more than others* (36%) than *much less than others* (15%) for infants for Visual Processing. These are represented in Table 4.14 with the percentage of the criteria met in the categories on the INDeSC checklist linked by the experts to Visual Processing (Appendix L).

This higher percentage of item scores (50%) indicating a definite or probable difference for *more than others* or probable difference for *less than others* may be linked to the high percentage of NDSC criteria not being met in the NHCU. Under Visual Processing this included the linked categories of Handling techniques, Environmental adaptation and Feeding on the INDeSC. Items in each category that has a score of 80% or more for not meeting the NDSC principles or a Score of *1 – no criteria met*, were identified since the lack of implementation of criteria on these items specifically may link to sensory modulation disorder in Visual Processing.

Most items were found under the Environmental adaptation category related to light reduction. Items that were not adhered to were ambient light not being is reduced/dimmed and direct light over the infants with little control of bedside light. Incubator covers not used and shading of daylight was not provided. Light levels were not measured in the incubator which were subjected to continuous bright light since no day/night cycle was provided with 12 hours of low light at night. The lack of dimmed lights and a quite time where infants were not handled meant infants went without long periods for sleep.

Table 4.14 Percentage of items on the Infant Sensory Profile™ 2 reflecting sensory processing levels (more and less than others) and the percentage criteria and items for categories on the INDeSC linked to visual processing

Type of sensory modulation		Mean percentage criteria score for all categories on the INDeSC linked to visual processing		Items in each category with No criteria met score 80% of the time and over
		%		
Visual processing items %		Family centred philosophy		
Definite difference - Much more	36.36	1 No criteria met	41.67	
		2 and 3 Some criteria met	16.67	
		4 All criteria met	41.67	
		Positioning		
		1 No criteria met	50.00	
		2 and 3 Some criteria met	12.50	
Probable difference- More	13.63	4 All criteria met	37.50	
		Handling techniques		
		1 No criteria met	82.50	Care changes as infants matures.
		2 and 3 Some criteria met	2.92	The unit has quiet times where all routine care and interventions are delayed
Typical	**12.50**	4 All criteria met	14.58	Care interventions are clustered around sleep
		Environmental adaptation (manipulation)		
		1 No criteria met	87.50	Ambient light is reduced/dimmed Incubator covers are used with closed incubators Direct bright light is avoided
Probable difference- Less	21.59	2 and 3 Some criteria met	5.36	Bedside lights are titrated/controlled Light levels inside incubators are measured One source of daylight is used with a shading device Overhead lights are dimmed Toys. pictures and appropriate music used to reduce sensory monotony
		4 All criteria met	7.14	The unit provides cycled light Day/night cycle is provided with 12 hours of low light and sound at night
		Feeding		
Definite difference - Much less	15.09	1 No criteria met	100.00	Preterm infants are prepared for feeding.
		2 and 3 Some criteria met	0.00	
		4 All criteria met	0.00	

4.5.2.4 Tactile Processing

The percentage of the three items for the 22 infants for Tactile Processing on the ISP 2, on which infants scored a definite and probable difference, more or less than others and typical, was established. A higher percent of items on the ISP 2 were scored as *much more than others* (53%) than *much less than others* (13%) for infants for Tactile Processing. These are represented in Table 4.15 with the percentage of the criteria met in the categories on the INDeSC checklist linked by the experts to Tactile Processing (Appendix L).

Table 4.15 Percentage of items on the Infant Sensory Profile™ 2 reflecting sensory processing levels (more and less than others) and the percentage criteria and items for categories on the INDeSC linked to tactile processing

<table>
<tr><th colspan="2">Type of sensory modulation</th><th colspan="2">Mean percentage criteria score for all categories on the INDeSC linked to tactile processing</th><th>Items in each category with No criteria met score 80% of the time and over</th></tr>
<tr><td colspan="2"></td><td colspan="2">%</td><td></td></tr>
<tr><td colspan="2">Tactile processing items %</td><td colspan="3">Family centred philosophy</td></tr>
<tr><td rowspan="4">Definite difference - Much more</td><td rowspan="4">53.03</td><td>1 No criteria met</td><td>27.78</td><td></td></tr>
<tr><td>2 and 3 Some criteria met</td><td>12.50</td><td></td></tr>
<tr><td>4 All criteria met</td><td>59.73</td><td></td></tr>
<tr><td colspan="3">Positioning</td></tr>
<tr><td rowspan="5">Probable difference- More</td><td rowspan="5">10.60</td><td>1 No criteria met</td><td>46.87</td><td></td></tr>
<tr><td>2 and 3 Some criteria met</td><td>14.58</td><td></td></tr>
<tr><td>4 All criteria met</td><td>38.54</td><td></td></tr>
<tr><td colspan="3">Handling techniques</td></tr>
<tr><td rowspan="3">1 No criteria met</td><td rowspan="3">73.70</td><td>Care changes as infants matures.</td></tr>
<tr><td rowspan="5">Typical</td><td rowspan="5">10.60</td><td>The care giver supports gradual state changes</td></tr>
<tr><td>The unit has quiet times where all routine care and interventions are delayed</td></tr>
<tr><td rowspan="3">2 and 3 Some criteria met</td><td rowspan="3">9.50</td><td>Care interventions are clustered around sleep.</td></tr>
<tr><td>The infant is provided with "time-out"</td></tr>
<tr><td>Preterm infants are swaddled.</td></tr>
<tr><td rowspan="6">Probable difference- Less</td><td rowspan="6">13.03</td><td rowspan="3">4 All criteria met</td><td rowspan="3">16.80</td><td>Preterm infants are moved slowly, as a whole</td></tr>
<tr><td>Infants are provided with opportunities for grasping.</td></tr>
<tr><td>Non-nutritive sucking is provided to support self-regulation</td></tr>
<tr><td colspan="3">Environmental adaptation (manipulation)</td></tr>
<tr><td>1 No criteria met</td><td>84.03</td><td rowspan="3">Toys. pictures and appropriate music used to reduce sensory monotony</td></tr>
<tr><td>2 and 3 Some criteria met</td><td>6.25</td></tr>
<tr><td>Definite difference - Much less</td><td>12.74</td><td>4 All criteria met</td><td>9.72</td></tr>
</table>

		Feeding		
		1 No criteria met	93.75	Preterm infants are prepared for feeding.
		2 and 3 Some criteria met	2.08	Preterm infants are positioned in a way that prevents the need for repositioning after a gavage feed
		4 All criteria met	4.17	

This higher percentage of item scores (64%) indicating a definite or probable difference for *more than others,* may be linked to the high percentage of NDSC criteria not being met in the NHCU. Under Tactile Processing this included the linked categories of Handling techniques, Environmental adaptation and Feeding on the INDeSC. Items in each category that has a score of 80% or more for not meeting the NDSC principles or a Score of *1 – no criteria met*, were identified since the lack of implementation of criteria on these items specifically may link to sensory modulation disorder in Tactile Processing.

Most items were found under the Handling techniques category related to care changing as infants matured and caregivers supporting gradual state changes during handling. This further included very limited quite times where all routine care and interventions are delayed, care was not clustered around sleep and infants were also not provided with "time-out" or rest periods so they may have been touched and handled frequently, even when sleeping. The infants were not swaddled or moved slowly, as a whole, keeping the body and head aligned and limbs tucked in, so they did not receive calming pressure in terms of tactile input. Non-nutritive sucking or opportunities for grasping were rarely provided for self-regulation. Infants were also not prepared and positioned for feeding and had to be touched and repositioned after feeding.

4.5.2.5 Movement Processing

The percentage of the four items for the 22 infants for Movement Processing on the ISP 2, on which infants scored a definite and probable difference, more or less than others and typical was, established. A higher percent of items on the ISP 2 were scored as *much more than others* (34%) than *much less than others* (24%) for infants for Movement Processing. These are represented in Table 4.16 with the percentage of the criteria met the categories on the INDeSC checklist linked by the experts to

Movement Processing associated with sensory modulation in the proprioceptive sensory systems (Appendix L).

This higher percentage (49%) of a definite or probable difference in the item scores for *more than others* may be linked to items with a high percentage of NDSC criteria not being met more than 80% of the time in the NHCU which may have affected modulation in movement processing resulting in particularly over responsivity in the infants in this study. Most items were found under the Handling category related to light reduction and sleep. The unit does not delay care and intervention so the infants can have dedicated quiet time for sleep. Infants were further moved irrespective of their cues or when asleep, they were not provided with pressure from swaddling and were not moved with the bodies in alignment with limbs flexed. Under the Positioning category infants were not positioned in a flexed, prone or side-lying position with midline orientation and under the Feeding category the moving of infants or need for repositioning after feeding was not considered.

Table 4.16 Percentage of items on the Infant Sensory Profile™ 2 reflecting sensory processing levels (more and less than others) and the percentage criteria and items for categories on the INDeSC linked to movement processing

Type of sensory modulation		**Mean percentage criteria score for all categories on the INDeSC linked to tactile processing**		**Items in each category with No criteria met score 80% of the time and over**
		%		
Movement processing items %		**Family centred philosophy**		
Definite difference - Much more	34.00	1 No criteria met	8.75	
		2 and 3 Some criteria met	17.19	
		4 All criteria met	74.06	
		Positioning		
		1 No criteria met	67.03	The neck is in neutral position with the head in midline in line with the body.
		2 and 3 Some criteria met	10.65	The shoulders are protracted
Probable difference- More	14.77	4 All criteria met	22.32	Prone or side-lying positions are rather used than supine, especially in acutely ill infants
		Handling techniques		
		1 No criteria met	76.87	Care changes as infants matures
				The unit has quiet times where all routine care and interventions are delayed.
Typical	**15.90**	2 and 3 Some criteria met	7.71	Care interventions are clustered around sleep.
				The infant is provided with "time-out" or rest periods according to his/her cues
				Preterm infants are swaddled.

		4 All criteria met	15.42	Preterm infants are moved slowly. as a whole. keeping the body and head aligned and limbs tucked in.
		Environmental adaptation (manipulation)		
Probable difference- Less	11.36	1 No criteria met	76.04	Toys. pictures and appropriate music used to reduce sensory monotony
		2 and 3 Some criteria met	9.37	
		4 All criteria met	14.58	
		Feeding		
Definite difference - Much less	23.86	1 No criteria met	95.83	Preterm infants are prepared for feeding.
		2 and 3 Some criteria met	1.39	Preterm infants are positioned in a way that prevents the need for repositioning after a gavage feed.
		4 All criteria met	2.78	Non-nutritive sucking is provided during gavage feeding.

4.5.2.6 Oral Processing

The percentage of the two items for the 22 infants for oral processing on the ISP 2, on which infants scored a definite and probable difference, more or less than others and typical, was established. A higher percent of items on the ISP 2 were scored as *much more than others* (41%) for infants for oral processing than *much less than others* (22%). These are represented in Table 4.17 with the percentage of the criteria met the categories on the INDeSC checklist linked by the experts to oral processing associated with sensory modulation in the proprioceptive sensory systems (Appendix L).

This higher percentage (55%) of a definite and probable difference in the item scores for both more than and probable difference for less than others may be linked to items with a lack of criteria being met more than 80% of the time in the NHCU which may have affected modulation in oral processing resulting in particularly over responsivity in the infants in this study.

Most of these INDeSC items related to the Handling and Feeding categories. Infants were not prepared and positioned for feeding and needed to be moved after feeding. No7n-nutritive sucking was never provided during gavage feeding with nasogastric tubes reducing oral input. Since routine care and interventions are not delayed and care is not clustered around sleep and "time-out" or rest periods are not provided it is possible that oral input is inconsistent and feeding interrupted.

Table 4.17 Percentage of items on the Infant Sensory Profile™ 2 reflecting sensory processing levels (more and less than others) and the percentage criteria and items for categories on the INDeSC linked to oral processing

Type of sensory modulation		Mean percentage criteria score for all categories on the INDeSC linked to oral processing		Items in each category with No criteria met score 80% of the time and over
		%		
Oral processing items %		**Family centred philosophy**		
Definite difference - Much more	40.90	1 No criteria met	41.67	
		2 and 3 Some criteria met	16.67	
		4 All criteria met	41.67	
Probable difference- More	13.63	**Handling techniques**		
		1 No criteria met	68.75	Care changes as infants matures.
		2 and 3 Some criteria met	2.60	The unit has quiet times where all routine cares and interventions are delayed.
				Care interventions are clustered around sleep.
				The infant is provided with "time-out" or rest periods according to his/her cues
Typical	**11.00**	4 All criteria met	28.65	Infants are provided with opportunities for grasping.
		Environmental adaptation (manipulation)		
		1 No criteria met	89.58	Toys, pictures and appropriate music used to reduce sensory monotony
		2 and 3 Some criteria met	0.0	
Probable difference- Less	12.15	4 All criteria met	10.42	
		Pain management		
		1 No criteria met	100.00	Non-nutritive sucking is provided during painful minor procedures
		2 and 3 Some criteria met	0.0	
Definite difference - Much less	22.32	4 All criteria met	0.0	
		Feeding		
		1 No criteria met	95.83	Preterm infants are prepared for feeding.
		2 and 3 Some criteria met	1.39	Preterm infants are positioned in a way that prevents the need for repositioning after a gavage feed.
		4 All criteria met	2.78	Non-nutritive sucking is provided during gavage feeding.

The items on the INDeSC which did not meet the criteria on the checklist in 80% of observations linked to different sensory processing systems differed for each system. This indicates the environment may have influenced the infants' sensory modulation but, in this study, the descriptive nature of the data cannot infer any causal relationship.

PHASE 2

4.6 The Infant Sensory Profile™ 2 (ISP 2) 3-6 Months

4.6.1 Sensory modulation and quadrants – comparison 3-6 months and 4 weeks post discharge

4.6.1.1 Sensory processing at 3-6 months

The total score on the sensory profile was analysed when the infants were assessed at 3-6 months according to five categories (Figure 4.3). Of the 10 infants who returned for this assessment, 70% (n=7) presented with sensory modulation *much more than others*, which indicated definite over responsivity. This remained unchanged for these seven infants from the assessment at 4 weeks.

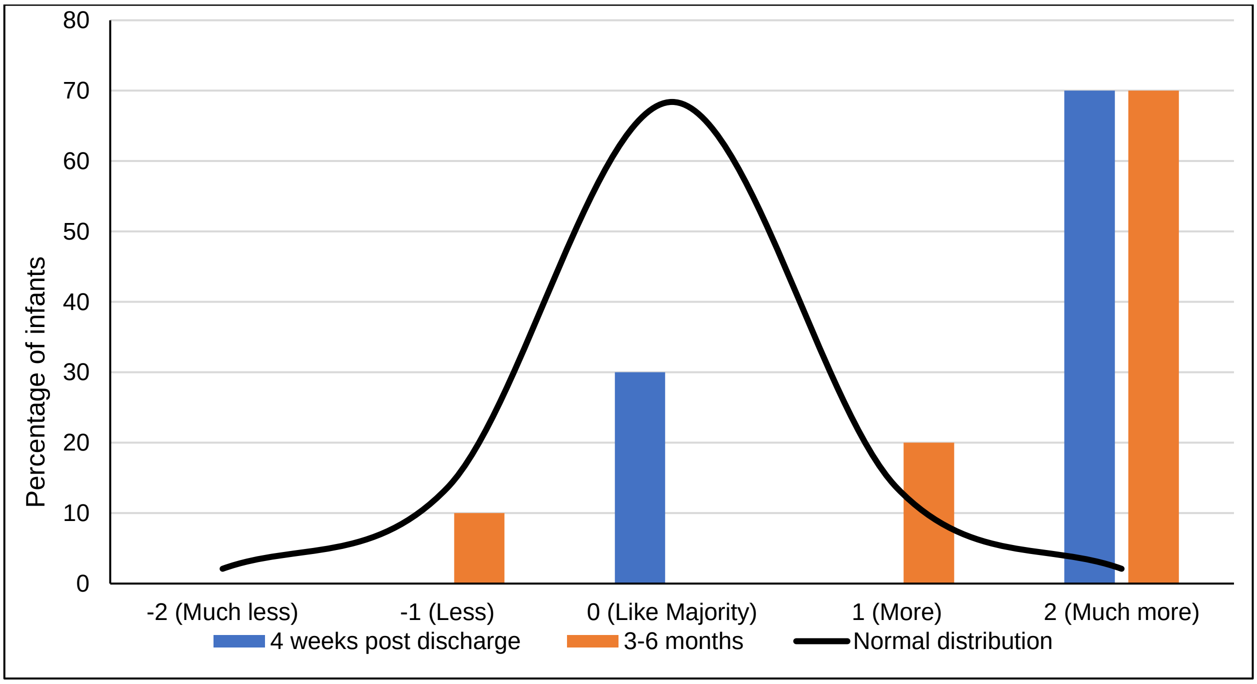

Figure 4.3 Percentage of infants scoring in the categories of sensory modulation on the Infant Sensory Profile™ 2 for the infants who returned at 3-6 months (corrected age) compared to their sensory profile at 4 weeks post discharge (n=10)

The other infants fell into the *more* (20%; n=2) group which indicated over responsivity *more than others* and the *less* (10%; n=1) group which indicated under responsivity *less than others* infants with sensory modulation. None of the infants that returned at 3-6 months continued to fall into the typical like majority group, even though they scored in this category at 4 weeks.

4.6.1.2 The quadrant scores at 3-6 months.

The frequency of infants presenting in each of the quadrants; seeking, avoiding, sensitivity and registration, were compared for those infants who did return at 4 weeks and at 3-6 months (corrected age) and compared to the range of quadrant scores found at 4 weeks post discharge for those infants who returned (Figure 4.4).

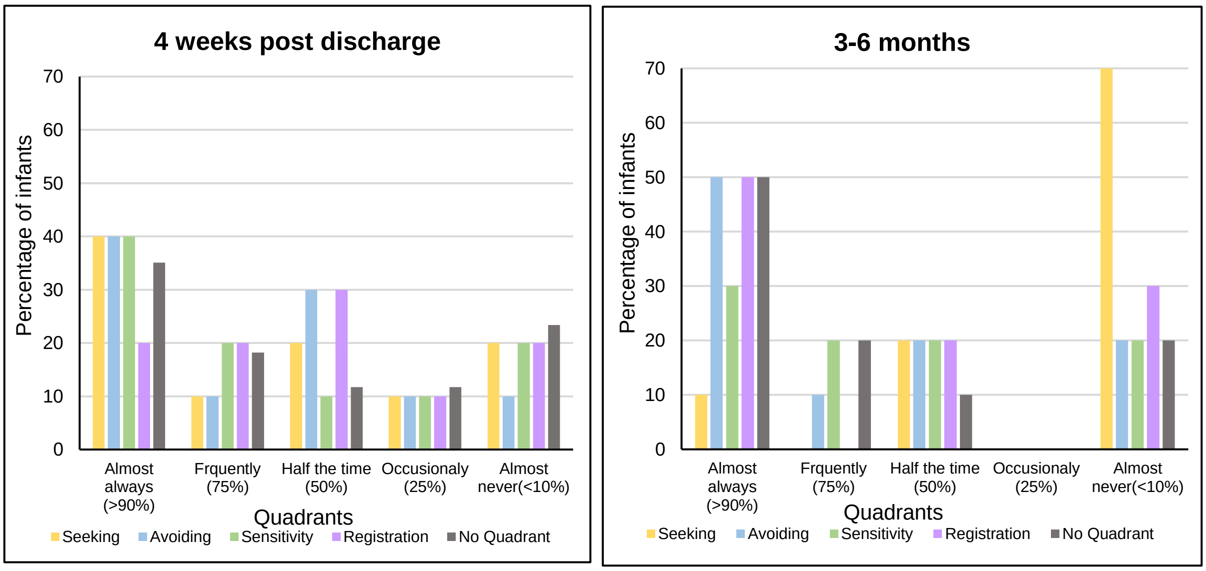

Figure 4.4 Percentage of infants in each score range for the quadrants of at 4 weeks post discharge compared to 3-6 months (corrected age) for infants who did return (n=10)

A higher percentage of infants (50%; n=5) who returned at 3-6 months were reported to almost always use active avoiding and engage in behaviours to manage or control sensory input and registration to passively self-regulate where they allowed sensory experiences to happen and then reacted to them. They were demonstrating an active response in relation to their low sensory threshold and a lower percentage of infants scored almost always for the sensitivity quadrant at 3-6 months. A significant reduction (p=0.001) was seen in the frequency of sensory seeking behaviour between 4 weeks post discharge and 3-6 months.

4.6.2 Sensory modulation and quadrants – comparison of the infants who returned and those who did not return

4.6.2.1 Sensory processing of the infants who returned and those who did not return

When comparing the sensory profile of infants who returned for the follow-up appointment and those who did not return, a significant difference was found between the two groups (p=0.036). Infants who returned in the study were more likely to have SMD when the results for the 4 weeks post discharge were compared with infants who returned and those who did not return, particularly over responsivity at a definite difference *much more than others* (Figure 4.5).

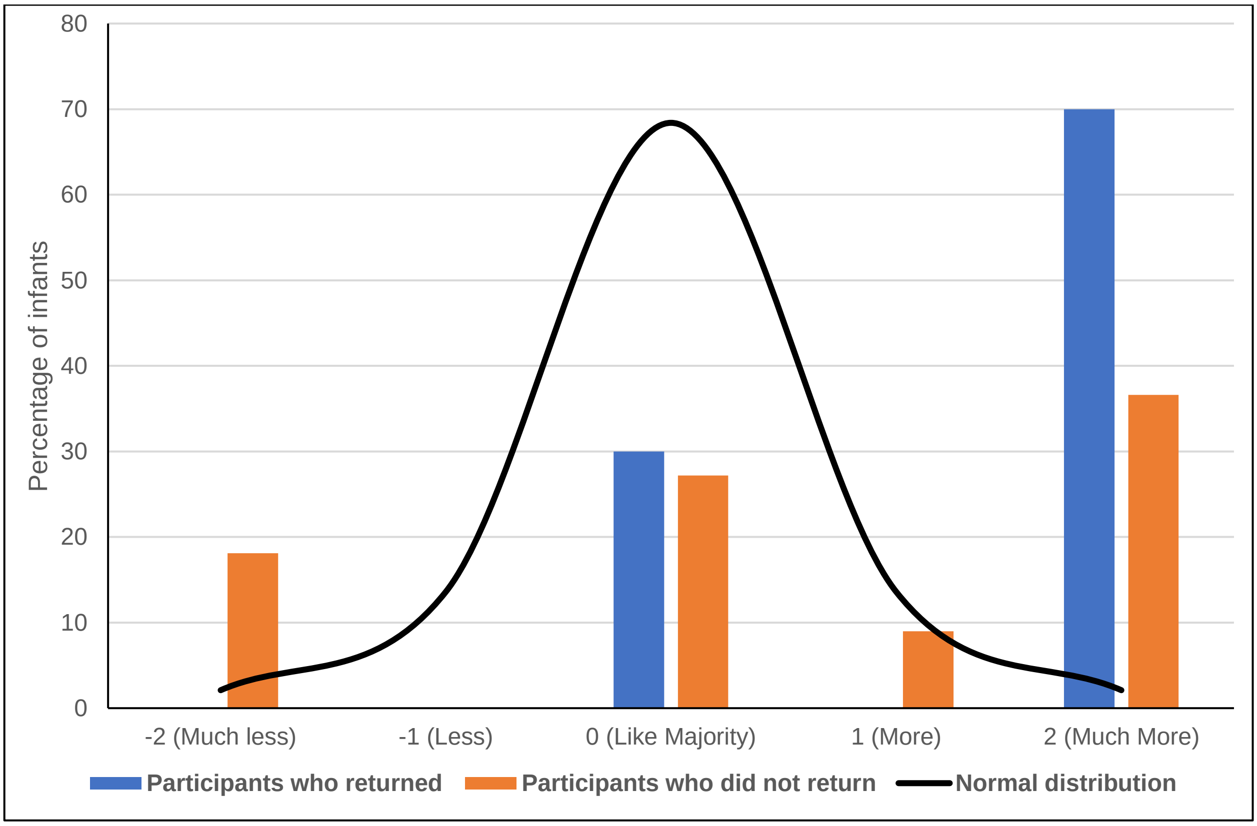

Figure 4.5 Percentage of infants scoring in the categories of sensory modulation on the Infant Sensory Profile™ 2 for the infants who did (n=10) and did not return at 3-6 months (n=12)

4.6.2.2 The sensory quadrants at 4 weeks post discharge for those that did and did not return at 3-6 months.

There was a significant difference for all the quadrant behaviours of the infants who returned for the follow-up appointment and those who did not return (0.001).

This indicates the infants who returned more frequently displayed seeking, avoiding and sensitivity behaviour indicating SMD related to both high and low thresholds. Those who did not return showed seeking less frequently and none of the infants who did not return scored almost always for any quadrant. Both groups scored frequently for sensitivity (Figure 4.6), which is congruent with the over responsivity (*much more than others*) recorded for both groups, although this occurred in fewer infants who did not return (Figure 4.5).

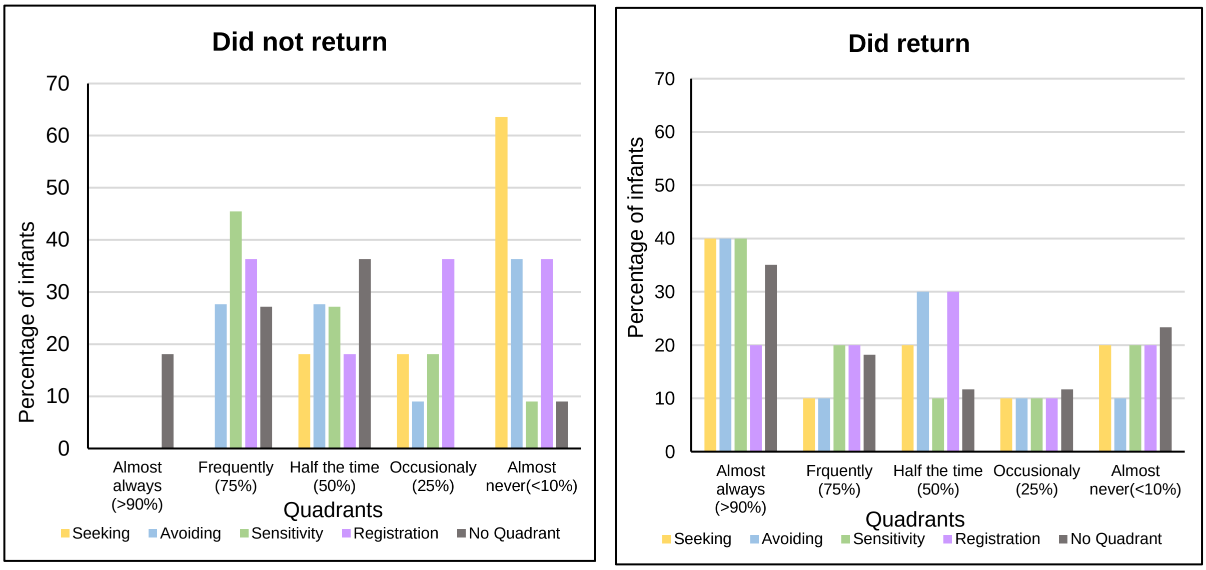

Figure 4.6 Quadrants of infants who did not return (n=12) and infants who did return (n=10) at 4 weeks post discharge.

4.7 The Bayley Scale of Infant and Toddler Development III - Third Edition®

Descriptive statistics of the Bayley-III are described below for infants who returned for follow up appointments at 3-6 months. The mean composite scores for motor, cognitive, language and social-emotional function as well as adaptive behaviour were analysed. The mean composite scores for motor, cognitive and language fell below 85 indicating dysfunction for this group of participants for these components (Table 4.18).

Table 4.18 Mean composite scores for the Bayley Scales of Infant and Toddler Development III

Composite scores	Mean	SD
Motor	72.10	20.90
Cognitive	72.50	6.43
Language	70.80	15.95
Social-emotional	106.60	33.73
Adaptive behaviour	100.70	35.23

The z scores were analysed according to a normal distribution curve to establish the percentage of infants who presented with typical development; those who were at risk or had mild, moderate or severe dysfunction. The z scores are presented in the following paragraphs.

4.7.1 Motor Scale (Fine and Gross Motor)

With regard to the fine motor skills, 30% (n=3) of the participant scores were within the typical age range of development. With regard to the fine motor skills, 30% (n=3) of the participant scores were within the typical age range of development and 10% scored above the typical range (+1SD), however, 50% (n=5) of the participant scores indicated a severe dysfunction (-3SD) and 10% (n=1) indicated moderate dysfunction (-2SD). Similar results were obtained for the infants' gross motor skills. Severe dysfunction was identified in 30% (n=3) of the infants at 3 standard deviations below the typical age development. Moderate dysfunction was identified in 40% (n=4) of the infants with 2 standard deviations below the typical age development, and lastly 30% (n=3) of the infants were identified to have a mild dysfunction with 1 standard deviation below the normal age development (Figure 4.7).

The level of dysfunction was confirmed by the composite motor score indicating 30% (n=3) of infants had severe dysfunction at 3 standard deviations below the typical age development, 30% (n=3) had moderate dysfunction at 2 standard deviations below the typical age development and 20% (n=2) had mild dysfunction at 1 standard deviations below the typical age development. Only 20% (n=2) of the infants fell in the normal range of development in the z score range of 0.

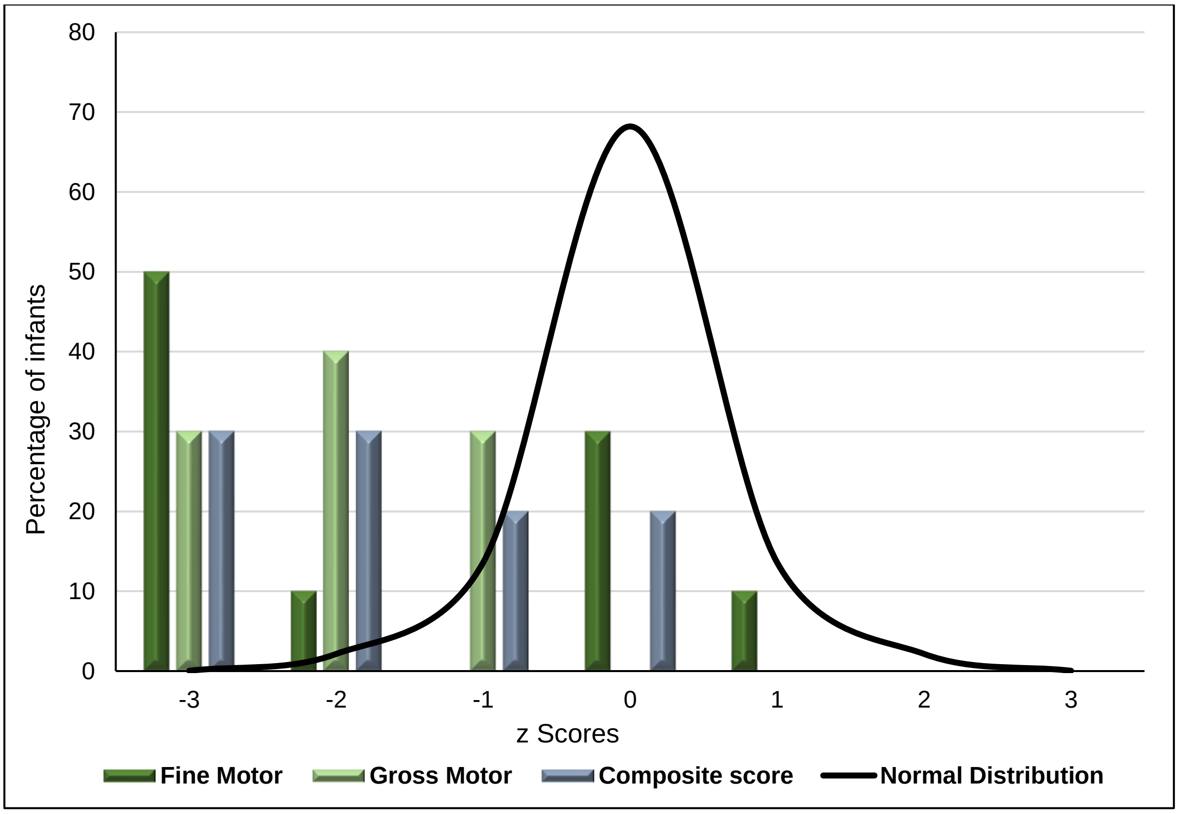

Figure 4.7 z Scores on the Bayley Scales of Infant and Toddler Development III – fine and gross motor component (n=10)

4.7.2 Cognition

Figure 4.8 indicates 70% (n=7) of the infants in the group who returned for follow up functions fell below the typical range of development in terms of their cognition based on scaled scores and composite scores.

With regard to cognition, 20% (n=2) of the participant scores were within the typical age range of development and 10% scored above the typical range (+1SD), however, 40% (n=4) of the participant scores indicated a severe dysfunction (-3SD) and 10% (n=1) indicated moderate dysfunction (-2SD).

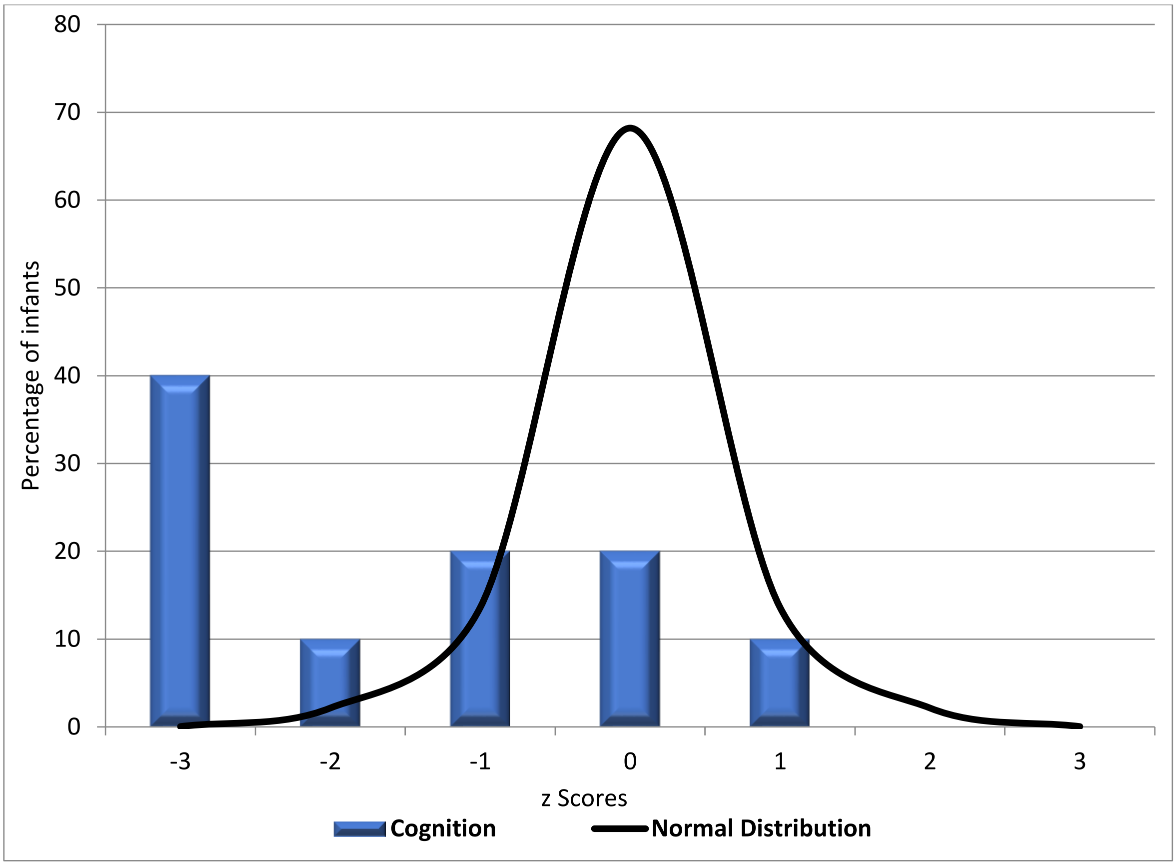

Figure 4.8 z Scores on the Bayley Scales of Infant and Toddler Development III – cognitive component (n=10)

4.7.3 Language

With regard to receptive communication (RC) skills, infants in the group who did return for follow up demonstrated that 30% (n=3) of the infants had a mild dysfunction, falling 1 standard deviation below the typical age development, and 40% (n=4) had a moderate dysfunction, falling 2 standard deviations below the typical age development. Thirty percent (n=3) of the participant scores indicated a severe dysfunction at 3 standard deviations below the typical age development (Figure 4.9).

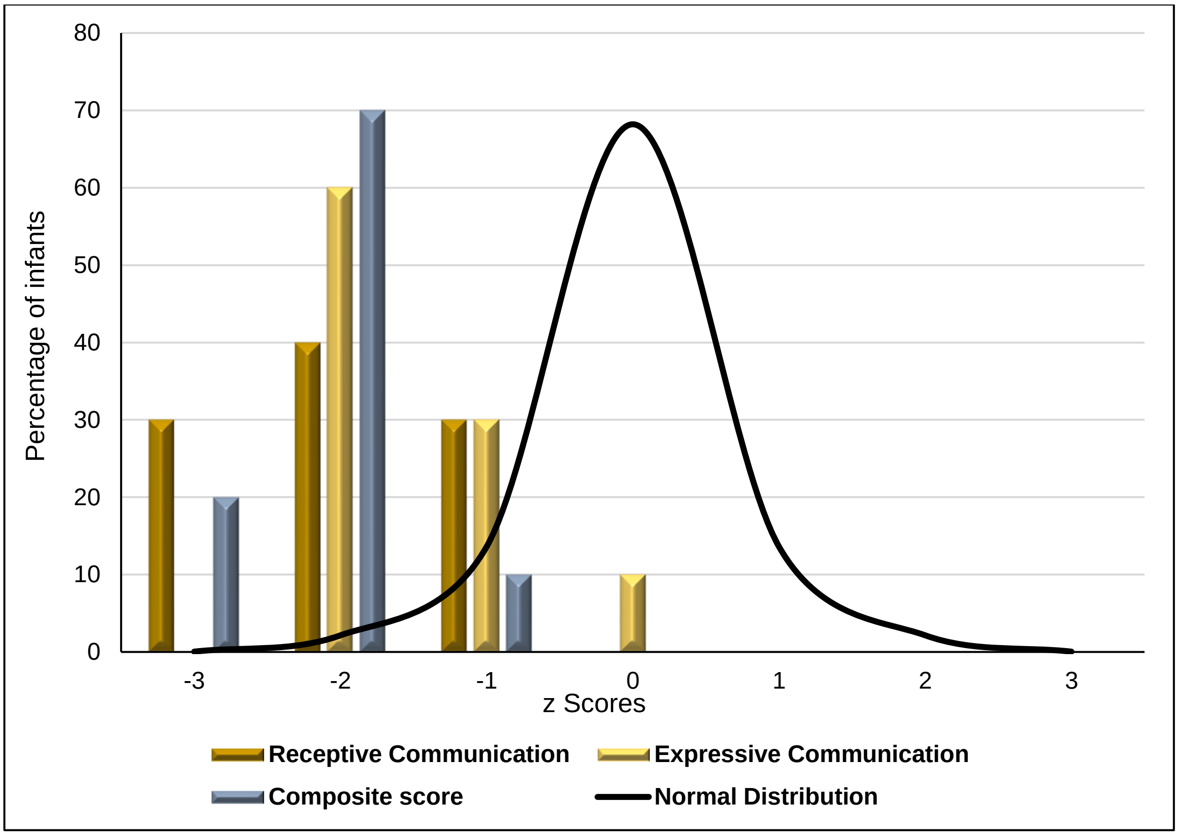

Figure 4.9 z Scores on the Bayley Scales of Infant and Toddler Development III – communication component (n=10)

Similar results were obtained for the infants' expressive communication (EC) skills. Ten percent (n=1) fell within the typical age range of development, with 30% (n=3) of the infants with mild dysfunction were identified at 1 standard deviation below the normative curve. Moderate dysfunction was identified in 60% (n=6) of the infants with 2 standard deviations below the normal age development. This dysfunction was confirmed by the composite communication score with 70% (n=7) infants scoring with moderate dysfunction at 2 standard deviations below the normal age development.

4.7.4 Social-Emotional

With regard to z scores for social-emotional behaviour, infants in the group who did return for follow-up had 20% (n=2) falling within the typical age range of development. Thirty percent (n=3) of the infants had a moderate dysfunction, falling 2 standard deviations below the typical age development. Fifty percent (n=5) of the infants had scores indicating function above the normal age development with 40% (n=4) of the infants with 3 standard deviations above the typical age development and 10% (n=1) at 1 standard deviation above the typical age development (Figure 4.10).

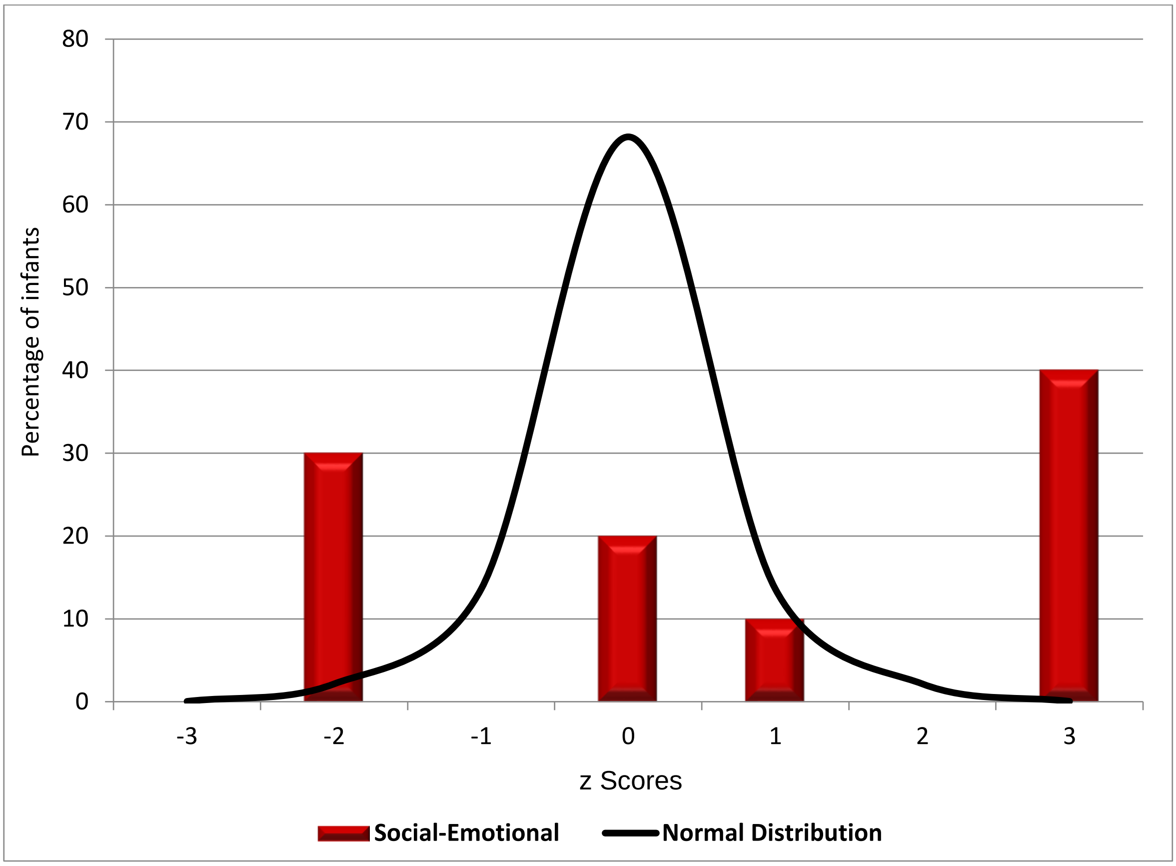

Figure 4.10 z Scores on the Bayley Scales of Infant and Toddler Development III – social-emotional component (n=10)

4.7.5 Adaptive Behaviour

Adaptive behaviour indicates infants in the group who did return for follow up demonstrated 50% (n=5), falling within the typical age range of development with regard to their conceptual behaviour (communication and self-direction) and motor behaviour. For social behaviour (leisure and social) the infants scored between -2 and 2 standard deviations below and above the typical age range of development with 40% (n=4) having mild to moderate dysfunction. For practical behaviour (health and safety and self-care) scores ranged from +3 to -3 standard deviation above and below the typical age development with 30% (n=3) infants having a severe dysfunction, falling 3 standard deviations below the typical age development and 10% (n=1) having mild dysfunction falling 1 standard deviation below the typical age development (Figure 4.11). The composite adaptive behaviour score indicates 70% (n=7) of infants scoring within the typical or above the normal age developmental level.

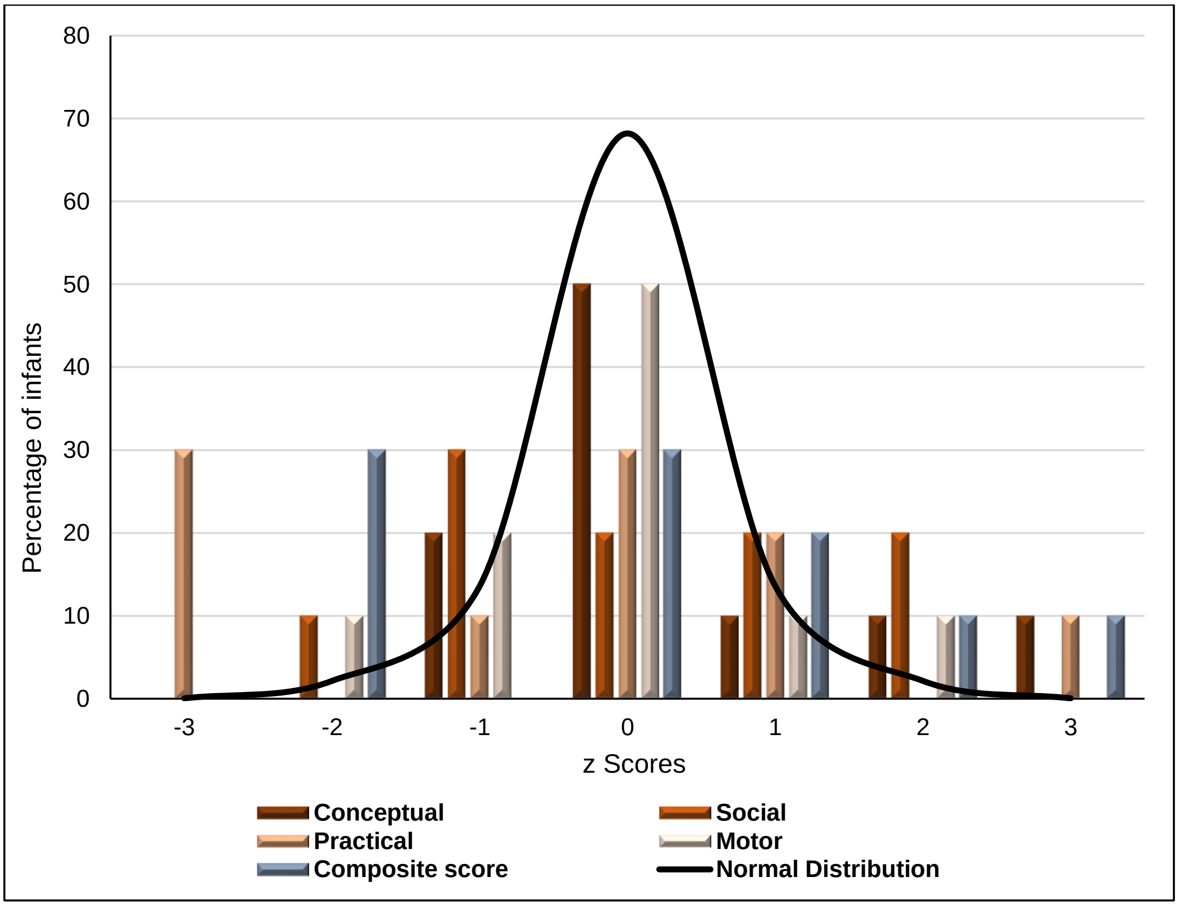

Figure 4.11 z Scores on the Bayley Scales of Infant and Toddler Development III – adaptive behaviour component (n=10)

4.7.6 The Infant Sensory Profile™ 2 and the Bayley Scales of Infant and Toddler Development III

When the raw scores and normal curve cut off scores (z scores) for the ISP 2 and the Bayley scaled scores and composite scores for each infant were compared there was no clear trend for developmental delay in infants with SMD. All the infants presented with risk for SMD (*much more than, more than and less than others*) (Table 4.19).

Table 4.19 Raw scores for the Infant Sensory Profile-2 and scaled and composite scores for the Bayley Scales of Infant and Toddler Development III with z scores for each infant (n=10)

Participant code	ISP 2 4 weeks total score and z score (cut off category)	ISP 2 3-6 months total score and z score (cut off category)	Bailey-III Gross motor score scaled score (z-score)	Bailey-III Fine motor score scaled score (z-score)	**Bailey-III Motor scale composite score (z-score)**	**Bailey-III cognitive composite equivalent score (z-score)**	Bailey-III Receptive Communication (RC) score scaled score (z-score)	Bailey-III Expressive Communication (EC) score scaled score (z-score)	**Bailey-III Language composite score (z-score)**	**Mean (SD) composite score and composite equivalents for Bayley II**	**Bailey-III Social Emotional composite equivalent score (z-score)**	Bailey-III Adaptive Behaviour Conceptual scaled score (z-score)	Bailey-III Adaptive Behaviour Social score scaled score (z-score)	Bailey-III Adaptive Behaviour Practical score scaled score (z-score)	Bailey-III Adaptive Behaviour motor score scaled score (z-score)	**Bailey-III General Adaptive composite score(z-score)**	**Mean (SD) composite score and composite equivalents for Bayley II**
001	95 (2)	91 (2)	3 (-2.3)	13 (1.0)	88 (-0.9)	55 (-2.9)	4 (-2.0)	8 (-0.4)	77 (-1.5)	**73.33** (38.37)	145 (3.0)	13 (1.0)	10 (-1.7)	8 (-0.4)	9 (-0.2)	94 (-0.4)	**119.05** (36.06)
002	84 (2)	88 (2)	5 (-1.7)	1 (-2.9)	58 (-2.8)	55 (-2.9)	7 (-1.0)	5 (-1.7)	77 (-1.5)	**63.33** (11.35)	75 (-1.7)	10 (0.0)	12 (-1.7)	13 (1.0)	6 (-1.4)	117 (-1.1)	**96.00** (11.35)
003	87 (2)	92 (2)	6 (-1.4)	1 (-2.9)	61 (-2.6)	90 (-0.4)	1 (-2.9)	6 (-1.4)	62 (-2.5)	**71.00** (18.02)	95 (-0.2)	15 (1.7)	15 (-1.7)	8 (-0.4)	14 (1.4)	118 (-1.2)	**106.50** (18.02)
004	92 (2)	76 (2)	1 (-2)	1 (-2.9)	60 (-2.7)	79 (-1.4)	1 (-2.9)	4 (-2.0)	75 (-1.6)	**71.33** (9.26)	80 (-0.7)	7 (-1.0)	6 (-1.7)	7 (-1.0)	5 (-1.7)	99 (-0.5)	**87.50** (9.26)
005	98 (2)	87 (2)	5 (-1.7)	3 (-2.3)	64 (-2.4)	110 (0.7)	6 (-1.4)	6 (-1.4)	77 (-1.5)	**83.67** (36.27)	145 (3.0)	19 (3.0)	18 (-1.7)	19 (3.0)	16 (2.0)	155 (3.4)	**150** (7.07)
006	62 (1)	62 (1)	1 (-2.9)	2 (-2.6)	49 (-3.4)	47 (-3)	2 (-2.9)	5 (-1.7)	62 (-2.5)	**52.67** (46.64)	145 (3.0)	6 (-1.4)	8 (-0.4)	3 (-2.3)	8 (-0.4)	66 (-2.2)	**105.50** (55.86)
007	55 (0)	70 (1)	4 (-2.0)	10 (0)	67 (-1.9)	55 (-2.9)	5 (-1.7)	5 (-1.7)	71 (-1.9)	**64.33** (14.52)	90 (-0.4)	8 (-0.6)	7 (-1.7)	3 (-2.3)	7 (-1.0)	67 (-2.2)	**78.50** (4.95)
008	79 (2)	79 (2)	6 (-1.4)	12 (0.7)	94 (-0,4)	85 (-1.0)	7 (-1.0)	6 (-1.4)	79 (-1.4)	**86.00** (8.26)	75 (-1.7)	9 (-0.2)	5 (-1.7)	3 (-2.3)	11 (0.4)	68 (-2.1)	**71.50** (4.95)
009	53 (0)	39 (-1)	5 (-1.7)	13 (1.0)	94 (-0.4)	90 (-0.4)	4 (-2.0)	5 (-1.7)	68 (-2.5)	**84.00** (32.57)	145 (3.0)	10 (0.0)	12 (-1.7)	8 (-0.4)	10 (0.0)	95 (-0.3)	**120** (35.36)
010	89 (2)	93 (2)	6 (-1.4)	5 (-1.7)	73 (-1.8)	75 (-1.7)	3 (-2.3)	4 (-2.0)	77 (-1.5)	**75.00** (32.57)	75 (-1.7)	9 (-0.2)	9 (-0.2)	13 (1.0)	8 (-0.4)	98 (-0.1)	**86.50** (16.26)

The mean composite scores for motor, cognitive and language development which were observed by the researcher indicate infants' developmental scores varied irrespective of the ISP 2 results, with 90% (n=9) of the infants having mean borderline composite scores below 85 that indicated developmental delay. However, the infant with a mean composite scores above 85 (-1SD), had motor cognitive and language composite z scores which fell between 0 and -1.4 indicating typical development. Even though the infant presented with sensory processing *much more than others* (z score = 2) as did 70% (n=7) of other infants who presented with developmental delay at 4 weeks and 3-6 months post discharge. The infants that returned at 3-6 months therefore appear to be those with deficits with a mean composite score below 85 related to motor, cognitive, language development indicating developmental delay as well as sensory processing problems with 70% (n=7) of infants presenting with sensory scores indicating *much more than others* (z score = 2) and the other 3 infants having a sensory profile of *more than others* or *less than others* (z score = 1 or -1).

The mean composite scores for social-emotional and general adaptive behavior reported by the parent indicated less developmental delay with 20% (n=2) of infants scoring below 85 and 80% (n=8) of infants scoring in the typical range. Some of these infants who scored above 85 on the mean score did have composite scores below 85 on either the social-emotional (30%: n=3) and general adaptive behavior (30%: n=3) indicating they had delay in one component but not the other.

4.8 Summary

PHASE 1

In this study, 11 of the 22 infants were born earlier than 32 weeks gestation. The greatest percentage of infants (64%) weighed between 900-1400 grams, which indicated they fell into the extremely low and very low weight groups for premature infants. At 5 minutes, most infants scored an Apgar of 9 (36%) and at 10 minutes this had changed to 41%. With regard to colouring at birth, 86% of the infants were pink. Seventy-seven percent of the infants had a temperature of between 36°C-36.9°C. The highest number of infants

(27%) had a length of 38-40cm long and 77% of the infants stayed in NHCU for between 1-6 weeks.

When looking at the NHCU environment using the INDeSC checklist, the Neonatal High Care Design category had a mode of 1 for between 52% of the observations, indicating half of the time the NHCU did not simulate a uterine-like environment. With regard to Individualised Care, all the items had a mode of 1 for between 85% and 100% of the observations, indicating the individualised care principles were not applied in the NHCU. The Family Centred Philosophy category had 13 items of which five had a mode of 1 and six, related to parents as participants, had a mode of 4, which is reflected as a positive result within the NHCU. These mixed results indicate the Family Centred Philosophy principles were partially applied in the NHCU. The Positioning category of the INDeSC consisted of 12 items, nine of which had a mode of 1 for between 73%-85% of observations, indicating majority of these principles were not applied in the NHCU. The Handling Techniques category of the INDeSC consisted of 19 items and of these 15 had a mode of 1 for between 70%-100% of observations, indicating majority of these principles were not applied in the NHCU. The Environmental Manipulation category consisted of 32 items in total and 27 of these items had a mode of 1 for between 70%-100% of observations, indicating majority of these principles were not applied in the NHCU. The Pain Management category, the Knowledge of Infant Development and the Feeding category of the INDeSC, which consisted of a total of ten items, all had a mode of 1 for 8 items between 98%-100% of observations, indicating these principles were not applied in the NHCU.

Twenty-two infants discharged from the NHCU environment were assessed using the Infant Sensory Profile™ 2 (ISP 2) at 4 weeks post discharge. The total score on the ISP 2 was analysed according to the normal curve to classify the infant's sensory modulation according to five categories. These categories included: *much less than others* (-2 standard deviations below the normal curve), *less than others* (-1 standard deviation below the normal curve), *just like the majority* of others (0 standard deviations), *more than others* (+1 standard deviation above the normal curve) and *much more than others* (+2 standard deviations above the normal curve). Both +1SD and +2SD on the ISP 2 indicate over responsivity and therefore possible dysfunction. The frequency of infants for each of the quadrant scores on a 5-point scale, from almost always, frequently, half the time, occasionally and almost never, were presented for the four quadrants (seeking, avoiding, sensitivity and registration). Only 28% of the infants presented with sensory modulation that fell into the normal range. Just under sixty percent (n=13) of the infants were found to have sensory modulation difficulties in the much more than others category indicating over responsivity. When analysing the quadrant scores of the ISP 2, half of the infants presented almost always or frequently with sensitivity behaviour and over a third presented almost always or frequently with avoiding behaviour. Seeking behaviour occurred in 82% of the infants occasionally or almost never.

All items of the INDeSC checklist were linked to the different sensory systems of the ISP 2 by two Sensory Integration experts. Items which were observed as not being met 80% of the time were then described for the various sensory systems.

In all sensory systems the scores on the items on the ISP 2 indicated infants presented with a higher percentage of sensory modulation *much more than others.* Under General Processing a high percentage of item scores on the INDeSC checklist, where principles were not met in the NHCU, were in all the categories except Neonatal Intensive Care Design. A high percentage of item scores on the INDeSC checklist, where principles were not met in the NHCU linked to Auditory processing, Visual processing and Tactile processing were in the categories for Environmental manipulation (reduction of sound/light), Handling and Feeding. Movement processing was linked to a high percentage of items on the INDeSC checklist where principles were not met in the NHCU related to Positioning, Handling, Environmental manipulation and Feeding. For Oral processing a high percentage of items on the INDeSC checklist where principles were not met in the NHCU related to Handling, Environmental manipulation, Pain Management and Feeding. No causal relationship between the NHCU and sensory processing can, however, be inferred from this data.

PHASE 2

The total score on the sensory profile was analysed when the infants were assessed at 3-6 months according to five categories – *much less than others* (-2 standard deviations below the normal curve), *less than others* (-1 standard deviation below the normal curve), *just like the majority of others* (0 standard deviations), *more than others* (+1 standard deviation above the normal curve) and *much more than others* (+2 standard deviations above the normal curve). Of the 10 infants who returned for this assessment, 70% were at a higher risk for SMD *much more than others*, which indicated definite over responsivity to sensory information. A higher percentage of infants (50%) who returned at 3-6 months were reported to frequently use avoiding strategies, which is an active response with a low sensory threshold for regulation and was congruent with their over responsivity. Fifty percent of infants were also frequently using registration strategies. There was a significant reduction in the frequency of sensory seeking behaviour for infants from 4 weeks and 3-6 months (p=0.001).

When comparing the 4 weeks sensory profile results of infants who returned for the follow-up appointment and those who did not return, a significant difference was found for all quadrants between the two groups (p=0.001). Infants who returned in the study more frequently displayed seeking, avoiding and sensitivity behaviour related to both high and low thresholds indicating SMD. None of the infants who did not return scored almost always in any of the quadrants.

With regard to the infants' development measured with the Bayley-III, the infants' mean composite scores fell within the -1 standard deviation for the motor, cognition and language components. The composite score for motor skills indicated 30% of the infants had a severe delay, 30% had moderate delay and 20% had mild delay. With regard to cognitive scores, the infants in the group who did return for follow up 40% of the infants had a severe delay, 10% had moderate delay, 20% had mild delay while 30% scored at or above typical age range of development. When looking at the composite scores for language skills, the group who did return for follow up, 20% of the infants had a severe delay, 70% had moderate delay and 10% had mild delay. With regard to social-emotional behaviour, infants in the group who did return for follow up demonstrated 70% falling within or above the typical age range of development and 30% having moderate delay. Adaptive behaviour composite scores indicate infants in the group who did return for follow up demonstrated 30% with moderate delay and 70% falling within or above the typical age range of development. Infants who had a severe dysfunction had difficulties with the practical component (health and safety, as well as self-care abilities).

The comparison of the ISP 2 and Bayley-III scores indicated that the infants who did return were at risk for SMD (*much more than others, more than others and less than others*) with very little variation in the level of SMD. While 10% (n=1) of the infants had mean composite scores on the Bayley-III which did not indicate developmental delay, this infant had delay in some motor, cognitive and language skills observed by the researcher. Therefore, it was difficult to infer any link between SMD and specific composite scores on the Bayley-III, except that all infants in Phase 2 had deficits in sensory processing and development that required intervention in occupational therapy.

CHAPTER 5: DISCUSSION

5.1 Introduction

This chapter considers the demographic and NHCU environmental factors, at the time the infants were in the NHCU at Edenvale General Hospital. The sensory modulation of preterm infants at the age of 4 weeks post discharge from the hospital, was determined by using the Infant Sensory Profile™ 2 (ISP 2). The descriptive analysis of the SMD reported for the infants in the different sensory systems and the lack of criteria met according to the NDSC principles laid out in the INDeSC is discussed.

Infants were assessed again at 3-6 months post discharge from the hospital using the ISP 2 and the sensory modulation of the preterm infants at age 3-6 months (corrected age). Their developmental level using the Bayley Scale of Infant Development – 3rd Edition® (Bayley-III) is also discussed.

PHASE 1

5.2 Demographic, Medical and NHCU Environmental Factors

The first objective of the study was to determine the demographics of preterm infants and NHCU environmental factors, at the time the infants were in the NHCU at Edenvale General Hospital.

5.2.1 Demographic Information

The demographics gathered in this research matched most of the South African sample size statistics and are therefore congruent with South African premature infant statistics, such as those reported by Mackay et al. (2011) where approximately 43% of infants admitted to the NICU in Johannesburg were included in research on their first follow-up visit (World Health Organization, 2018).

Amongst those born prematurely, the highest percentage of infants (64%) were between 900-1400 grams, which indicated they fell into the extremely low and very low weight groups for premature infants. At 5 minutes, all but one infant had an Apgar of 7 and at 10 minutes this had changed to all infants having a score above 7 indicating good respiration, activity, breathing and pulse rate which could be considered that the infant was in good health (Chertoff, 2018). This supported the colouring at birth, where 86% of the infants were pink which is scored as 2 on the Apgar scale and shows good oxygenation (Chertoff, 2018). This indicates that by 10 minutes all the infants were breathing well. Seventy-seven (77.27%) of infants were not hypothermic at birth with temperatures between 36°C and 36.9°C even though they were premature. Low temperature is often (Chertoff, 2018) associated with prematurity due to lack of insulating body fat, immature nervous system and inability to efficiently conduct heat (Christiano, 2020). All the infants had a length of 32-43cm long which was less than the average length at birth for a full-term infant of about 50 cm. This was not unexpected in premature infants (Chertoff, 2018).

Infants were admitted to NHCU for between 1-6 weeks which is shorter than the reported median stay of premature infants of 10 weeks reported in the literature in the UK for NICU. The shorter stay in this study can be accounted for by the criteria for admission to the NHCU where infants did not require other intensive interventions. This applied to infants born between 24-34 weeks as in the current study with the greatest percentage of infants being born at 30 weeks or more (Seaton, et al., 2019).

A low socioeconomic status can increase the risk of preterm births and has been associated with lower levels of education in South Africa. Contrary to the findings of van Schalkwyk et al. (2020), 91% (n=20) of the mothers of the infants in the current study had a Grade 12 education or a tertiary qualification. This was a factor which could have assisted in the transfer of information to these mothers when involving them in the care of their infant.

5.2.2 Neonatal High Care Unit Environmental Factors

The researcher assessed the environment in the NHCU using a checklist - the Implementation of Neurodevelopmental Supportive Care (INDeSC) checklist. The INDeSC checklist allowed for the evaluation and description of the essential environmental factors within the NHCU (Lubbe, 2009). It describes the initial impression and design of the NHCU when the researcher first enters the environment.

The largest category within the INDeSC considers the environmental manipulation in the NHCU, and it is designed to simulate a uterine-like environment. This category is made up of subcategories, which include the management of light, noise, and olfactory stimulation (Lubbe, 2009). Results indicate that all the items in the Light and Olfactory subcategories in the Environmental Manipulation category had a mode of 1, with the exception of one item, *eye protection is used with phototherapy.* Eye protection with phototherapy is standard protocol within the NHCU at Edenvale General Hospital, therefore in 63% of observations the eyes of all infants who received phototherapy were covered when they spent one to two days under the ultraviolet lights to aid in their treatment to reduce bilirubin levels. Although this NDSC principle was therefore adhered to, the NHCU environment itself was bright, with the use of florescent lighting above multiple infant incubators was observed 100% of the time. The florescent light was left on continuously and although there were bedside lights, these were not used. In 100% of observations no shading devices were used to provide protection from daylight and bright lights. The lighting in the NHCU was not regulated as the blinds were constantly open. One of the main concerns observed 98% of the time was a lack of suggested “quiet time” that should be maintained during the day as well as night, with lights dimmed for several hours to assist in developing a day/night sleep schedule for the infants (Nair, et al., 2003). This resulted in a lack of diurnal rhythms and quite time for sleep, during the day with reduced light. Noise also had an effect as no attempt was made to have quiet times for sleep and this can result in sleep problems and impaired social development in preterm infants (Raman, 1997).

The Noise subcategory in the Environmental Manipulation category, did however meet some of the specified criteria on the INDeSC. Four of the 17 items in the Noise subcategory had a mode of 4, indicating sufficient application of these noise reduction principles related to the environment within the NHCU. Just over seventy-five percent of the Noise items scored, however, had a mode of 1. Noise reduction therefore adhered to more criteria than lighting, where 93% of the Light items never met the criteria on the

INDeSC (mode of 1). For Noise it was observed that items that scored a mode of 4 and that were carried out well in the NHCU were the items that were easy to adhere to, or items that contained equipment that had been used continuously in the NHCU. These items were: the bottoms/lids of trash cans were padded, incubator portholes were closed quietly by using the latch, ventilator tubes were emptied regularly with no water build-up and the charts and stock items were placed next to incubators, not on top. However, the noise levels in the NHCU were still unacceptable as the air conditioning, shared with the paediatric unit, ran continuously, and there was constant beeping of monitors and continuous loud staff conversations. The incubators were close to each other, leaving a chair space between the incubators, which allowed for parent discussions, infant crying and beeping of other monitors to be heard by multiple infants. Four incubators were placed next to the sliding doors, which were continuously opened and closed. These incubators were never rotated or moved. In 100% of observations in the Noise Reduction section, no attempt was made to play soft stimulating music, move the infants' incubators away from the centre of traffic or to provide effective sound absorption barriers between infant incubators such as curtains or padding. A similar result was found for the Immediate Infant Environment section with incubator covers never used, infants were never given soft ear-plugs or covers and sound levels were never monitored in the incubators. Staff generated noise, was not kept to a minimum in 81% of observations. Although these unmet items are found on the INDeSC checklist, not all the items can necessarily be realistically implemented for the NHCU at Edenvale General Hospital. The unit is small and it would be challenging to meet all items, for example to move the incubators away from the centre of traffic. The noise in the NHCU was similar or less than that reported in a study in Taiwan, which showed that during a 48-hour observation period, peak noises, due to human-related factors, were recorded in the NICU, some of which were above levels of 100-200 dB, which may damage cells in the ear (Chang, et al., 2001).

It was observed that 100% of the time no positive olfactory stimulation, such as the mother's smell, was provided in the incubators. Infants were exposed to other smells related to their care in terms of medicines and equipment. This can be linked to the Individual Care category of the INDeSC which focuses on the care the infant receives, with two subcategories related to observations and care provided by staff and caregivers in the NHCU. All of the items in this category had a mode of 1, indicating the individualised care principles were not applied in the NHCU. It appears that in the NHCU, parents/caregivers were unaware of and unable to identify the infant’s behavioural cues in 85% of observations and did not continuously and systematically assess and evaluate the infant's developmental needs in 100% of observations. They were thus unable to care and intervene when needed. This was due to a lack of information provided to the caregivers from the staff so the parents/caregivers were not empowered within the NHCU. Individual Care, based on behavioural cues such as signs of stress and stability in the infants, is also essential to minimise the effect of the NHCU environment on the infants (Nair, et al., 2003). Programmes such as the Neonatal Individualized Developmental Care and Assessment Program (NIDCAP) have been found to educate parents/caregivers on behaviour cues thus improving medical outcomes earlier, initiating feeding and supporting weight which results in shorter stays in the NICU and thus decreased costs when caring for preterm infants (Nair, et al., 2003).This finding is contradictory to Family-Centred Care Philosophy, which also considers empowerment of the parents/caregivers. The Family-Centred Philosophy category of the INDeSC includes Parents as Active Participants, Privacy and Comfort, Visitation and Parent Support Groups. For this category, eight of the 13 items had a mode of 2-4 indicating that more of the criteria in Family-Centred Care Philosophy were applied in the NHCU compared to the Individualised Care category. Six of the 13 items had a mode of 4, indicating sufficient application of the criteria in the Family Centred Philosophy category. One item scored a 3, indicating that parents were allowed to hold their infants which was observed on 66% of the time. This was a positive outcome in terms of staff within the NHCU supporting parents on some of the family-centred aspects. Parents were involved with care such as feeding, bathing and KMC 83% of the time, in 76% of the observation’s parents had personalise their infant's bed space, mothers were expressing milk for their infant or were breastfeeding in 97% of observations, and parents were allowed to see and touch their infant immediately after birth in 96% of observations.

It was observed 96% of the time parents/caregivers were not given privacy since the NHCU is an open ward. One privacy item scored 2, indicating that other criteria related to comfort are sometimes met within the NHCU. The curtains were always open and their dignity was somewhat disregarded. Guidelines for parental involvement suggest provision of a private area for breastfeeding and for kangaroo care (Nair, et al., 2003). It has been found in other studies, that Family Centred Care is often overlooked and a medical model approach is often used (Ashbaugh, et al., 1999). This may have had an impact on the quality and frequency of parent/caregiver involvement in the infant's care in the NHCU since no family support groups were offered. Parent involvement has been found to aid in and play a role in their ability to care for the infant at home after discharge due to a positive healthcare experience for infants, their families and their caregivers (Ashbaugh, et al., 1999; Lubbe, 2009; Nair, et al., 2003).

In terms of infant positioning within the NHCU, although some NDSC principles were addressed, others were lacking. The Positioning category of the INDeSC consisted of six subcategories and nine of the 12 items related to the anatomical position of infants and midline orientation had a mode of 1 indicating these criteria were not applied in the NHCU. Three items had a mode of 4, indicating sufficient application of the NDSC criteria. These were related to Containment, Flexion and Individualised bedding being used which were all observed as being met over 70% of the time. In the current study, it was observed that infants were not well positioned, except that their knees were flexed, which is only one aspect of correct positioning. This aspect requires addressing, as preterm infants lack muscle strength to control movements and tend to lie in an extended position (Case-Smith & O'Brien, 2013). This position has been related to abnormal tone and developmental delay and it is therefore better for preterm infants to be in a prone or side lying position, which better supports midline orientation (Nair, et al., 2003).

Only three out of the 19 items for Handling Techniques had a mode of 4, indicating sufficient application of the NDSC criteria. These three items specifically can be found in the following subcategories: Positive tactile stimulation and Movement. Fifteen items of Handling Techniques had a mode of 1, indicating these criteria were not applied in the NHCU and related to the following subcategories: care according to maturation and supporting state changes which were not met in 87% and 82% of observations respectively. No items in the Promotion of rest and sleep subcategory were observed for between 94% and 100% of the time. Modified hands-on care-giving by providing positive tactile stimulation was observed 50% of the time although it did not occur consistently but the promotion of self-regulation of the infants was never promoted. Not recognising stress cues such as tachycardia, bradycardia, apnoea and desaturation, and responses like hiccups or yawning when handling the preterm infant can also be detrimental, resulting in physiologic stress if handling is not adjusted according to these signs (Nair, et al., 2003; Vegara & Bigsby, 2004). It appeared there was little communication between the staff and parents with regard to the handling of an NHCU infant, particularly when drains and intravenous drips were present. This not only limits the amount of tactile input the infant is receiving, but also swaddling as most infants were nursed naked with no skin-to-skin contact. Limited handling techniques and swaddling of the infant in the NHCU has been identified in other studies to have an effect on the development of the preterm infant, including their bond with their mother or caregiver (Anderson, 1986; Aucott, et al., 2002; Feldman & Eidelman, 2003).

In the current study, none of the Pain Management criteria on the INDeSC, related to non-pharmaceutical pain reduction strategies, was adhered to with a mode of 1 scored for this category with no criteria met in 98%-100% of 48 observations. Pain management is very important as the infants in the NHCU are faced with daily heel picks or intraosseous infusion. They are further faced with the application and removal of plasters, which may not only be painful upon removal but may also aggravate the surface area of the skin (Nair, et al., 2003).

In the Knowledge of Infant Development category, some of the items of the subcategories related to staff knowledge shared between professionals and the Knowledge of the multidisciplinary team related to the preterm infant were observed in the NHCU. However, staff training and the education of parents in relation to the development of an infant, were scored a mode of 1 in the current study and these criteria were unmet 98%-100% of the time. The onus is on the multidisciplinary team, which included the doctors, nursing staff, speech therapists, physiotherapists and occupational therapists to empower parents in the care of their infant and educate them about the infant's development. Many studies have shown that staff need to empower themselves before they can empower the parents with knowledge, which may account for this result in the current study (Ashbaugh, et al., 1999; Flanagan, et al., 2019; Lubbe, 2009). The staff may have also not had the necessary information or training related to the infant cues, behaviours and developmental needs to empower the parents/caregivers. There was no observed attendance of any training by staff during the observation period. This unmet need in the NHCU correlates with other studies and indicates that limited education in the NHCU environment is lacking and is imperative to rectify this (Anderson, 1986; Lubbe, 2009).

The last category with regard to Neurodevelopmental Supportive Care is that of Feeding, which consists of three items related to the preparation of the infant for feeding. All three items on the INDeSC had a mode of 1, indicating these criteria were not applied in the NHCU between 98%-100% of the time. This category requires the infants to be prepared for feeding, which includes wrapping and positioning the infants. Most infants were fed using a nasal gastric tube because in the NHCU there was no non-nutritive sucking or pre-feeding used. Research shows that if infants do not have non-nutritive sucking while being fed via a nasogastric tube, they struggle to develop sucking and they therefore struggle to associate being full with feeding (Asadollahpour, et al., 2015).

In summary, there are some positive Neurodevelopmental Supportive Care aspects identified in the NHCU. Overall, this environment is not conducive in supporting the development of the preterm infant. It appears staff do not always have the necessary knowledge on NDSC and would potentially benefit from training on these principles. Various factors that can cause stress and sensory overload in the preterm infant have been identified and relate to the NHCU design, Individualised care, Family-centred philosophy, Positioning, Handling techniques, Environmental manipulation, Pain management, Knowledge of infant development and Feeding. It is important to consider these factors as they can impact on an infant's ability to modulate the sensory stimuli in their environment. If the preterm infant is unable to regulate their responses it could possibly lead to sensory modulation disorders.

5.3 The Infant Sensory Profile™ 2 (ISP 2) – 4 weeks post discharge

The second objective was to determine sensory modulation using the Infant Sensory Profile™ 2 (ISP 2) of preterm infants at age 4 weeks post discharge.

Research suggests and confirms that infants who are born prematurely are most likely admitted to the NICU (World Health Organization, 2018) and that stimuli in the NICU/NHCU can be both unusual and intense when compared to the stimuli the infants would have experienced in utero (Als & McAnulty, 2011; Mitchell, et al., 2015). Self-regulatory responses in the NICU/NHCU may become maladaptive and present as SMD even after the infant leaves the NICU/NHCU (Wickremasinghe, et al., 2013).

Prematurity with an admission into the NHCU/NICU can result in most infants having been overstimulated in the NHCU/NICU. At 4 weeks post discharge, the infants in the current study, were showing signs of sensory sensitivity, which is congruent with sensory over responsivity reported in infants who are treated in NICU/NHCU (Mento & Bisiacchi, 2012). Just under 60% (n=13) of participants were found to fall two standard deviations above the mean of sensory modulation on the normal distribution, indicating sensory modulation of *much more than others* (extreme responses to sensory events). Only a small percentage (9%) of the infants presented with scores two standard deviations below the mean of sensory modulation, indicating sensory modulation of *much less than others.* Under stimulation in the NICU/NHCU, has also been reported but is not as common (Bröring, et al., 2017). Sensory under responsivity may also have been related to “shut down” in the light of extreme over stimulation. Sensory modulation of *much more than others* and *much less than others* support the research that reported widespread altered CNS organisation in combination with the sensory over- and under-stimulation, which places these infants at risk for SMD (Bröring, et al., 2017). This indicates that these preterm infants were found to be at risk of SMD in 68% of these infants, which is higher than the percentage reported in another South African study where 54% percent of infants presented with probable and definite differences for sensory processing (Lecuona, et al., 2017). Those presenting with a definite difference at 4 weeks post discharge in this study, was higher than the 28%-40% reported later in life for preterm infants (Crozier, et al., 2016; Wickremasinghe, et al., 2013).

The scores according to quadrants for the total group at 4 weeks post discharge indicate that sensitivity of the infants was frequently or almost always reported for 50% of the participants, indicating a passive response to a low threshold, while a 32% frequently or almost always presented with avoiding behaviour of an active response to a low threshold and 36% frequently or almost always presented with registration. These infants appear to have used a passive response to self-regulate based on their high sensory threshold, which made them under responsive to sensory stimuli. The SMD for *much less than others* supported the less frequent seeking behaviour reported on the sensory quadrant for the infants at 4 weeks post discharge. These findings are congruent with atypical quadrants reported by Niutanen et al. (2020), although their most frequent score was for registration with a similar score for sensitivity followed by avoiding.

All the infants who partook in this stage of the research were monitored; the researcher provided the parents/caregivers with information to assist them with how to manage behaviour with regards to sensory overload, for example, excess screaming, avoiding feeding or reduced appetite. In summary, the Infant Sensory Profile™ 2 (ISP 2) of preterm infants at age 4 weeks post discharge identified 73% of infants who were at risk of SMD. Fifty percent of the infants (n=11) showed signs of sensory sensitivity, which is congruent with sensory over responsivity reported in infants treated in NICU/NHCU.

5.4 Demographics, the neonatal high care environment and the sensory profile

The third objective was to describe the preterm infants’ sensory modulation and the frequency of adherence to Neurodevelopmental Supportive Care criteria in the NHCU environment and the possible link between them. The sensory modulation on the ISP 2 of preterm infants at age 4 weeks was described and linked to the items on the INDeSC for which criteria were not adhered to in the NHCU to make it more uterine-like in 80% or more of the observations. The possible effect these items had in the NHCU environment which experts felt were linked to different types of sensory processing was considered based on the percentage of items on the ISP 2 which indicated sensory responses in relation to *more than others, typical and less than others* (Rahkonen, et al., 2015).

5.4.1 Association between the medical demographic factors and the Infant Sensory Profile™ 2

When the demographic factors of the infants, which mostly related to their birth, were correlated with their ISP 2 scores, only the head circumference had a low correlation with sensory modulation. This reflects the findings of a study that found approximately 10% of the sensory modulation disorder of late preterm infants to be explained by gestational age and head circumference (Bart, et al., 2011). At one year, children born as late preterm are at increased risk of developing sensory modulation disorder, showing decreased participation, and resulting in less parental satisfaction which has a coefficient of determination of 16% in their study (Bart, et al., 2011). In the current study, the variance (r^2) was 4.4%. This may be accounted for since a more heterogeneous and smaller sample, with infants that were more premature and assessed earlier, was used in the current study. Bart et al. (2011) in their study, only included infants born at 35-37 weeks, who were assessed at 12 months.

It appears differences in head circumference, a characteristic typically assessed in preterm infants, is the only variable that can be related to sensory modulation in the current study. This demographic factor is associated with the infant being born earlier and being more immature and therefore possibly more susceptible to adverse sensory input outside the womb. It must be expected that children with a smaller head circumference may also have brain abnormalities, which have also been associated with sensory modulation problems in preterm infants (Rahkonen, et al., 2015) .

Further research showed that preterm infants who had spent approximately 52 days in the NICU, compared with a sample of full-term infants, exhibited certain behaviours associated with sensory processing difficulties (Case-Smith, et al., 1998). According to the literature, most infants born premature do not have major developmental problems, however, those with lengthy stays in the NICU are at risk for sensory modulation disorders and developmental sequelae deficits (Case-Smith & O'Brien, 2013; Lubbe, 2008). No relationship for length of stay in the NHCU and SMD was found for the current study, which may be related to the nature of the NHCU, which differs from the NICU in that those infants requiring specialist care and surgery are not admitted to the NHCU. Thus, length of stay may be shorter in the NHCU, and therefore supports the current study, as majority of the infants were between 1-6 weeks (7-42 days) in the NICU (Robertson, et al., 2013).

5.4.2 The adherence of criteria met in the neonatal high care environment and the outcomes for types of sensory systems on the Infant Sensory Profile™ 2

With regard to the sensory profiles for the different sensory sections, the percentage of the different types of sensory processing were presented with the percentage non-adherence to criteria in the NHCU environment. Research indicates that the NICU environment may be related to SMD (Bröring, et al., 2017) and it has been noted that the dysfunction may be linked predominantly to the general, auditory and tactile sensory systems (Chow & Shellhaas, 2016; Wickremasinghe, et al., 2013). While in this study the highest percentage of definite and probable differences for *more than* was found on the items on the ISP 2 for these three sensory processing sections linked to different categories on the INDeSC where criteria for NDSC principles were not met in 80% of observations, the movement, visual and oral sensory sections also had a higher percentage of definite and probable differences.

In this study the linking described in no way indicates a causal relationship and only presents the possible impact the lack of NDSC and an adequate environment in the NHCU may have had on the sensory processing of the infants. For all sensory processing systems there were a higher percentage of items on the ISP 2 which indicated definite and probable difference *more than others* with a lower percentage of scores indicating definite and probable difference *less than others.* A very small percentage of infants scored in the typical *just like the majority of others* range. Each type of sensory processing will therefore be discussed below in relation to the effect of the environment on *much more than* and *more than others* sensory responses. Except for oral processing the results are similar to those reported by Crozier et al. (2016*).* They found a lower percentage of infants presented with oral processing problems (Crozier, et al., 2016).

General processing items measure the infant's ability to remain calm, their awareness of others, as well as the need for routines and schedules (Dunn, 2014). In this sensory section 62% of items scored definite and probable difference *more than others.* Four items in the Individualised care, one item in Family centred philosophy, four items in Positioning, 11 items in Handling, 9 items in Environment manipulation, one item in Pain management and three items in Feeding that did not meet criteria in 80% of observations were linked to General processing. Of these 33 items the majority fell in to the Handling category on the INDeSC where a lack of care changes as the infants matured using transitional touch and uninterrupted sleep with quiet times or "time-out," swaddling. Since care is not related to the infants' physiological state regulation, this may impact on the infants general processing since a routine based on their needs is not followed and procedures and care is imposed based on the medical and ward routines. The infants are not provided with a chance to develop a routine according to their needs, self-regulate and the noise in the NHCU as indicated under Environment manipulation further interrupts sleep. Calming interventions such as skin-to-skin care, slow movement and non-nutritive sucking are not provided and this may account for the infants later being over responsive to handling and irritable and hyper aware of noise and touch which may be experienced as painful on many occasions (Lubbe, 2009). Studies found statistically significant associations between pain experienced in the neonatal period and early developmental deficits, including delays in neuro-behavioural and brain function, which may result in SMD (Philpott-Robinson, et al., 2017). These findings support this study, as these infants also experienced a low threshold 4 weeks post discharge. Parents were also not prepared in terms of developing a routine for the infants when discharged. Infants were reported to have an inability to fall asleep without assistance later.

The high percentage of items scored at *more than others* for auditory and visual processing scores on the ISP 2 were mostly linked to items in the category on the INDeSC for Environmental manipulation which did not meet NDSC principles in 80% of the observations. This indicates that noise and lighting in the NHCU did not provide a supportive environment with 63% and 50% of items on the ISP 2 indicating a definite and probable difference *more than others* for auditory and visual processing respectively. Infants in the NHCU in the current study were exposed to both excessive sound and light (Als & McAnulty, 2011; Stevens, et al., 2014). Although some attempt was made to reduce the noise in the NHCU, the sound levels due to alarms and staff voices was above the accepted decibel level with a lack of sound absorbing environmental adaptations. The

NHCU was constantly bright with the fluorescent lights remaining on during the day and, as reported by staff, on at night as well to enable the staff to read charts. This exposure to a noisy environment in premature infants may result in neurons forming alternate pathways and a different feedback pattern between the cerebral cortex and the brainstem (Catlett & Holditch-Davis, 1990). Development is no longer occurring in utero and as a result and due to their immature nervous systems, premature infants are particularly susceptible to loud noise (Lahav & Skoe, 2014). Research also indicates negative outcomes of the NICU sensory environment and exposure to bright lighting in the NICU, which may have a damaging effect on some aspects of later motor development. It must be noted that there remains a lack of evidence that links the presence of retinopathy of premature infants and monitoring lights in the NICU (Philpott-Robinson, et al., 2017).

It is not until 32 to 34 weeks gestation that infants are able to coordinate autonomic responses to environment and their decreased autonomic and self-regulatory abilities mean they cannot selectively limit incoming stimuli (Bowden, et al., 2020). If the input exceeds the infant's capacity to respond, the infant will actively withdraw from it and over stimulation may be associated with over responsivity in infants in NICU.

Consistent overly bright lights may deter the infants from opening their eyes and taking in the environment around them (Als & McAnulty, 2011), thus creating sensitivity behaviour to light stimuli. This may also result in the infant not looking away and becoming restless to avoid visual input or, blinking a lot due to sensitivity. The excessive noise and light in the NHCU may account for the oversensitivity to auditory and visual stimuli reported for these infants at 4 weeks post discharge.

The high percentage of items scored at *more than others* for tactile processing scores on the ISP 2 were mostly linked to items in the category on the INDeSC for Handling which did not meet NDSC principles in 80% of observations. This indicates that care in the NHCU only addressed the infants' physiological state. Sixty-three percent of the items on the ISP 2 indicating a definite and probable difference *more than others* for tactile processing. Infants in the NHCU in the current study were handled without concern for periods of sleep and state changes or maturity of the infants (Als & McAnulty, 2011; Stevens, et al., 2014). This may have played the greatest role in infants becoming over responsive to touch since the environment of the infant can lead to behavioural stress, for example, touch can be stressful rather than soothing (Als & McAnulty, 2011). It has been found that handling and lack of positive tactile input and pain are closely related (Côté, et al., 1991). Positive gentle touch based on the infant's response and skin-to-skin touch is recommended (Nair, et al., 2003). Infants in the NHCU were observed to have drains and intravenous drips attached while in the supine position, thus not only limiting the amount of tactile input but also limiting the opportunity for swaddling and self-regulation. In relation to the sensory quadrants, most infants reacted to tactile stimuli and were found to be in the sensitivity quadrant, which is a passive response as they received noxious stimuli causing pain and discomfort within the NHCU environment (Als & McAnulty, 2011; Lubbe, 2009; Stevens, et al., 2014), resulting in the infants almost never seeking touch.

When considering movement processing, less than 50% of the items on the ISP 2 indicated over responsivity, Thus the impact of the lack of criteria met for care and environment in the NHCU may be less for sensory processing assessed in this section. The percentage of items scored at *more than others* for movement processing scores on the ISP 2 were mostly linked to items in the categories on the INDeSC for Positioning, Handling and Feeding which did not meet NDSC principles in 80% of observations. This indicates that care in the NHCU did not address the factors related to the infant's movement with 49% of items on the ISP 2 indicating a definite and probable difference *more than others* for movement processing. Infants in the NHCU in the current study were handled, fed and positioned without concern for the infant's maturity or state changes which are improved by a flexed prone or side lying position. Good positioning can also improve sleeping and feeding (Als & McAnulty, 2011; Stevens, et al., 2014). The correct anatomical foetal position was not maintained and the infants were not moved as a whole in a flexed position which may have had an impact on their movement processing at 4 weeks post discharge. Infants were reported to fuss and cry when moved and be resistant to an extended position at this stage.

The high percentage of items scored at *more than others* for oral processing scores on the ISP 2 were mostly linked to items in the categories on the INDeSC for Handling and

Feeding which did not meet NDSC principles in 80% of observations. This indicates that care in the NHCU did not address the factors related to oral processing with 55% of items on the ISP 2 indicating a definite and probable difference *more than others*. Infants in the NHCU in the current study were also fed and positioned without concern for the infant's maturity or state changes, repositioning infants after feeding and not providing non-nutritive sucking with nasogastric feeding, therefore resulting in the infants not being able to suck adequately; this was also seen in Feldman and Eidelman's study conducted in 2003 (Feldman & Eidelman, 2003). This has been associated with feeding assistance required, usually a nasogastric tube in the NHCU (Philpott-Robinson, et al., 2017).

Only 9% (n=2) of the infants in this study had sensory modulation that was *much less than others.* This indicates as suggested by Crozier et al. (2011) that some infants were unresponsive in terms of sensory processing in all sensory sections (Crozier, et al., 2016). This has been related to habituation of sensory input or shut down due to over stimulation described above (Case-Smith, et al., 1998).

It was important to determine if the SMD assessed at 4 weeks post discharge was still present in the infants at 3-6 months (corrected age) as they matured, as literature indicates that SMD could reduce as the child gets older. It was important if infants continued to present with SMD to provide a more intense intervention programme for them at this stage and therefore, follow up appointments are needed at 3-6 months of age and as the child further develops.

PHASE 2

5.5 The Infant Sensory Profile™ 2 (ISP 2) 3-6 Months

The fourth objective was to determine the sensory modulation using the Infant Sensory Profile™ 2 (ISP 2) of preterm infants at age 3-6 months (corrected age).

Within the study, 10 participants returned for their follow-up appointment. When determining their sensory profiles, it was noted that all of the infants presented with sensory modulation, which indicated a definite over responsivity for 70% of them having a *much more than others* score. This information suggests that after being discharged from the NHCU, the infants had difficulty modulating sensory information and still showed signs of SMD. This has been supported by research, as symptoms of sensory modulation disorders have been related to preterm infants (Adams, et al., 2015; Bart, et al., 2011). None of the infants' sensory profiles fell into the negative standard deviations indicting much less than others.

5.5.1 Sensory modulation and quadrants – comparison 3-6 months and 4 weeks post discharge (corrected age).

The fifth objective was to compare the sensory profile of the preterm infants who returned and those who did not return at 3-6months (corrected age).

5.5.1.1 Change in sensory profile from 4 weeks post discharge to 3-6 months

The frequency of infants presenting in each of the quadrants of the sensory profile: seeking, avoiding, sensitivity and registration, were also determined and compared to the range of quadrant scores found at 4 weeks post discharge and 3-6 months (Figure 4.4).

When looking at the quadrant scores of the sensory profile of the infants at 4 weeks post discharge and 3-6 months follow-up appointment, it must be understood that possible changes in the infants' sensory profiles may have been influenced by neural connectivity, such as white matter microstructure (Owen, et al., 2013; Philpott-Robinson, et al., 2017). This literature indicates that disrupted posterior and anterior white matter microstructure are found in infants with confirmed SMD and therefore supports this current study, that SMD may still be present at 3-6months (Owen, et al., 2013; Philpott-Robinson, et al., 2017).

When comparing their sensory profiles at 4 weeks post discharge, infants now used significantly less sensory seeking behaviour to self-regulate, which is an active response to a high sensory threshold at 3-6 months. It can be seen that a higher percentage of infants (60%) who returned at 3-6 months were reported to use the sensory regulation style of avoiding almost always and frequently, which is an active response with a low sensory threshold for regulation and 60% used registration which is a passive response to a high threshold. Ten percent of infants used sensitivity behaviour which is an active response to a high threshold, almost always only. As reported by Niutanen (2020) avoiding, sensitivity and registration behaviour to regulate is seen most frequently in premature infants, and maternal involvement and developmental support may improve medical and neurodevelopmental outcomes of preterm infants, particularly if they are provided with appropriate tactile stimuli (Stevens, et al., 2014). Being in a NHCU incubator supports this study's suggestion that the caregiver/mother may have an influence on the infants' threshold, and not being in constant contact with their mothers/caregivers, suggests the infants have not learned how to self-regulate, as their behavioural cues within the NHCU were not met or seen to; this then resulted in using avoiding behaviour. Research does support a decrease in self-regulation and an increase in avoiding, sensitivity and registration behaviours should an infants' needs not be met within the NICU environment (Aucott, et al., 2002; Lubbe, 2009). With shifting the strategy to using passive and active self-regulation or "shut down" in the light of extreme overstimulation or under stimulation, places these infants at risk for SMD depending on their ability to habituate to sensory stimuli (Bart, et al., 2011).

This could indicate that the infants at 3-6 months post discharge attempted to regulate the amount of information they were exposed to by using an active or passive approach, in the form of an avoiding or sensitivity style for a low threshold and a passive approach, in the form of a registration style for a high threshold. These behaviours could include them crying, "acting out," in an attempt to avoid certain stimuli, distress or appearing not to register sensory input around them. These are their efforts to make exposure to a stimulus more predictable. Early intervention and knowledge gained by filling in the sensory profile may have also played a role in these infant's shifting their approach, as the infant's caregivers/mothers filled out the sensory profile at 4 weeks post discharge, which may have aided in the way the caregiver/parent adapted the infant's environment to alleviate any possible stressors.

5.5.1.2 Comparison of the sensory profile at 4 weeks post discharge of infants who did and did not return at 3-6 months

The total score on the sensory profile was analysed according to the five categories to classify the infant's sensory modulation. A significant difference was found for all sensory sections for those who did return for their follow-up appointment and those who did not return at 3-6 months (corrected age). This significance indicates infants who returned in the study were more likely to have SMD when the results for the 4-week ISP 2 were compared to those who did not return. This shows that the return of participants with higher percentage in the *much more than others* category possibly had SMD and that the loss to follow up cannot be considered completely at random. When analysing the quadrants of the infants at 3-6 months of age (corrected age), it was found that at this stage the infants who did return were at a higher risk for presenting with SMD, and more frequently displayed avoiding, sensitivity and registration behaviour.

This information corresponds with studies that identify infants at risk of disabilities as early as possible (Flanagan, et al., 2019; Shenai & Bijlani, 2010), thus enabling a more precise evaluation of the efficacy of early intervention, as the researcher was able to identify and intervene as early as 4 weeks post discharge. Just as in the use of the Premature Infant Pain Profile (PIPP), the practicality and feasibility for using the Sensory Profile in clinical practice assisted the researcher in early intervention and possibly assisted in preventing sensory problems in the preterm infants with regard to their identified problematic sensory systems (Côté, et al., 1991; Wickremasinghe, et al., 2013). Being unable to modulate sensory information has an impact on an infant’s ability to function, if the infant is unable to modulate information, they find it difficult to learn about their surroundings and therefore, may become overstimulated leading to a meltdown or shut down (Williamson & Anzalone, 2001).

In summary, amongst the infants who did return at 3-6 months for their follow up appointment, presented with a higher risk of sensory modulation disorders, with a higher percentage reported to be frequently and almost always using the sensory regulation style of avoiding and sensitivity, which is an active and passive response with a low sensory threshold for regulation and registration which is a passive response to a high threshold. When comparing the sensory profiles of infants who did return and those who did not return at 3-6 month, a significant difference was found, indicating that those who returned in the study were more likely to have SMD when the results for the 4-week ISP 2 were compared.

5.6 The Bayley Scale of Infant and Toddler Development III - Third Edition®

The sixth objective was to determine the developmental level of the preterm infants at age 3-6 months using the Bayley Scale of Infant Development – 3rd Edition® (Bayley-III).

The researcher wanted to determine the infants' developmental delay, which may result from their premature birth. The Bayley-III was used to assess the infant's development across five domains: Cognitive, Language (Receptive & Expressive), Motor (Gross & Fine), Social-Emotional and Adaptive Behaviour. Research on preterm infants under one year reporting developmental delay using the Bayley-III is limited, with most studies following up with these children after 18 months to 6 years of age. This made it difficult to compare the scores reported in the current study to previous research, particularly since the infants who returned for follow up appointments at 3-6 months appeared to be at greater risk for developmental delay. The mothers who brought their infants for reassessment were possibly those who recognised difficulties or were concerned about the infant's development.

With regard to the Cognition 40% had severe delay, 10% of participants had a moderate cognitive delay and 20% had a mild delay. These results were similar to those reported for preterm infants from 2010-2015, where 47% of preterm infants were found to have severe delay and 22% borderline or mild impairment at 2 years for very low (<1500g) and extremely low (< 1000 g) birth weight infants, which represents most infants in the current study (Courchia, et al., 2019). Other research indicated that medium- and long-term outcomes in 50-70% of very and extremely low birth weight preterm infants, present with cognitive and learning difficulties, attention-deficit/hyperactivity disorder, and specific neuropsychological deficits in pre-school (Caravale, et al., 2005; Ross & Perlman, 2019). These findings were further supported by results of a study that indicated that length of stay in the NICU was associated with cognitive scores on the Bayley-III. Thus, for infants with higher birth weights, cognitive scores showed that 62% of participants fell in the normal range at that stage with 29% having mild delay and 9% having moderate delay (Ross & Perlman, 2019).

The Language Scale (receptive and expressive communication combined) demonstrated that overall, 60% of infants had a moderate delay in EC while 40% of infants had a moderate delay in RC. The composite scores indicate that 10% had a mild delay for language while 70% had moderate delay and 20% had severe delay. Anderson et al. (2010) found a similar percentage of mild delay, but only 7% had a moderate delay and 2% severe delay. The difference may reflect that only infants whose mothers were concerned about their development were assessed in the current study. Verbalisation or making sounds was reported as occurring very infrequently by the mothers of these infants on the ISP 2. Although the infants in the current study had more moderate deficits with expressive delay, previous studies on language development have found that premature children are comparatively delayed in expressive and receptive language (Fouché, et al., 2018; Msall & Tremont, 2002). Vocabulary delays are also evident after premature birth (Fouché, et al., 2018; Lester, et al., 2014; Msall & Tremont, 2002) with differences in grammatical comprehension abilities between preterm and term approaching significance.

With regard to the Motor Scale the composite scores indicate that 80% of the infants presented with motor delay. For fine motor skills 50% of the participant scores indicated a severe dysfunction and 10% indicated moderate dysfunction. One hundred percent of the infants presented with severe, moderate or mild gross motor delay and thus the results indicate that the infants presented with more gross motor dysfunction than fine motor dysfunction. Research has shown that a greater gestational age at birth is associated with improved Fine Motor Subscale performance (Greene, et al., 2013).

The results obtained for the participants' gross motor skills are similar to the findings on the Bayley-III and Bayley-II in 7-month-old infants born preterm (Reuner , et al., 2013). It appears therefore that at the of age 3-6 months motor deficits are more evident; other studies have also reported rates of moderate to severe motor delay (Hintz, et al., 2005). Anderson et al. (2010) found that one-third of the extremely preterm/extremely low birth weight group exhibited even higher proportions of motor delay.

The last two scales on the Bayley-III, the Social-Emotional Scale and the Adaptive Behaviour Scale are self-report questionnaires, which are completed by the parent/caregiver of the infant. Far fewer infants presented with developmental delay on these scales and with regard to social-emotional behaviour and infants who did return for follow up demonstrated only 30% had a mild delay or problems in socially engaging within their home environment. The skills assessed included mastery of functional emotional skills, communicating needs, engaging others and establishing relationships. The areas measured in adaptive behaviour include social, conceptual, practical and motor. Adaptive behaviour indicates participants in the group who did return for follow-up demonstrated, for conceptual, motor and social adaptive behaviours 30% of infants had either mild or moderate delay and the General Adaptive Composite (GAC) score indicated 20% of infants had moderate delay. Ten percent of the infants also had a mild delay, for practical behaviour while 30% had severe delay. The questions in this section covered questions related to avoiding, bumping into walls or objects, sleeping through the night, drinking from a cup or aiding in dressing. Some questions appeared to be for a higher age band, which could explain why these infants scored lower for this behaviour, despite correcting their age in the study.

The participants in this study predominantly fell within the normative distribution curve for their adaptive behaviour. The studies that report Bayley-III scores for infants under one year do not include scores for the Social-Emotional Scale and the Adaptive Behaviour Scale, thus there is limited research against which to compare the results of the current study. For the standardisation of the Adaptive Behaviour Scale of Bayley-III, only 2.88% of infants were included and this, together with a lack of information on sample characteristics on the atypical subgroups and distribution in age bands, may explain the infants' distribution of the infants' abilities when assessed by parents in the current study (Reuner , et al., 2013). However, research shows that preterm infants continue to have clinically significant problems with socio-emotional and adaptive functioning that persist throughout childhood and result in disproportionately high rates of impairment leading to the need for special education placement (Greene, et al., 2013).

In summary, a degree of developmental delay was identified in the Cognitive, Language (Receptive & Expressive), Motor (Gross & Fine), Social-Emotional and Adaptive areas when assessing the developmental level of the preterm infants at age 3-6 months.

5.7 The Infant Sensory Profile™ 2 and the Bayley Scales of Infant and Toddler Development III

The last objective was to describe the sensory modulation of preterm infants at age 3-6 months (corrected age) and their developmental level using the Bayley Scale of Infant Development – 3rd Edition® (Bayley-III).

No trend could be found for the scores on the ISP 2 and the Bayley-III when the scores for each infant were compared for developmental delay in infants with SMD. All the infants presented with risk for SMD (*much more than, more than and less than others*) as well as developmental delay. Delay in gross motor, cognitive, receptive communication and expressive communication, was identified on the Bayley III with regards to the composite scores indicating mild to moderate development delay. It was not possible in this sample to compare the scores statistically as there was little variation in the normal curve cut offs for the 10 infants. This result was expected as literature discusses how premature infants, with low range gestational ages and low birth weights, have a risk of poor sensory modulation coupled with neurodevelopmental delay that is demonstrated by poor performance on standardised developmental assessments (McGowan, et al., 2011; Philpott-Robinson, et al., 2017).

According to the literature, the impact of early neonatal care has not yet been considered and surrounding factors have not been fully explored to eliminate developmental delays in preterm infants and that preterm infants admitted to the Neonatal Intensive Care Unit are at higher risk of poor neurodevelopmental and sensory outcomes later in their lives (Bart, et al., 2011; McGowan, et al., 2011; Philpott-Robinson, et al., 2017). Despite what literature reported for older children, the results of the current study found deficits in both the overall ISP 2 and the Bayley-III scores for all the infants.

Other studies have reported a lack of association between sensory processing and development assessed on the Bayley-III. A study by Wiener et al. (2009) revealed that multiple linear regression models showed only a significant positive association, between Bayley-III motor score and the Test of Sensory Functions in Infants™ (TSFI) scores for the ocular motor control domain in children between the ages of 7-18 months of age. The infant ISP 2 is only a screening of sensory modulation and the child needs to be assessed as a toddler with SP 2 in order for SMD to be confirmed, as there is normative data with which to compare the Sensory Profile. The ISP 2, however, gives an indication of SMD to monitor the children (Dunn, 2005) (Dunn, 2014).

In summary, when considering the relationship between the ISP 2 and the Bayley-III, no trends were noted.

5.8 Limitations of the Study

- Limitations include administration specific limitations, which relate to records that were provided from the neonatal wards that were not always adequate. The proposed plan was to obtain all the birth history and pregnancy information from the discharge summaries in the participants' files, which were not always available or accurate. Information that was not available had to be provided by the parents and caregivers, which may not always be reliable due to certain constraints, such as their inability to recall accurate information, language barriers, or illiteracy.
- Another limitation to the study was the researcher was only able to carry out the checklist within the NHCU during the day. It is necessary to take cognisance of the fact that night routines were not witnessed and, should further studies be conducted similar to this one, this factor will need to be considered.
- The study was limited by the very specific homogeneous sample, as all participants attended Edenvale General Hospital, thus within a geographical area with a low income, making it difficult to generalise findings to other infant groups in South Africa.
- A low sample size of 10 participants returning at 3-6 months can be seen as a limitation, causing insufficient power to achieve a possible significance.
- The study had a limited number of experts who took part in the assignment of sensory processing systems. Increase in experts may have yielded a different validation of relationships between the measures.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 Main Findings

This study provided insight into the specific developmental outcomes of infants born prematurely at Edenvale General Hospital. It furthermore provided an understanding of the effect of not adhering to neurodevelopmental supportive care (NDSC) criteria which facilitate a uterine-like environment in the Neonatal High Care Unit (NHCU). The study further provided information on the sensory modulation of these preterm infants at 4 weeks post discharge as well as their sensory modulation and development at 3-6 months post discharge from the NHCU at Edenvale General Hospital.

The parents/caregivers of twenty-two infant participants were invited to participate in the study while the infants were in the NHCU at Edenvale Hospital. These infants matched the inclusion criteria which were: infants who were born less than 37 weeks gestation, admitted into the NHCU and who spent at least one week in the NHCU. The Implementation of Neurodevelopmental Supportive Care (INDeSC) checklist, designed by Welma Lubbe, was used to understand and describe the essential NDSC criteria within the NHCU. This indicated that for majority of the INDeSC categories, the environment of the NHCU did not meet the criteria of a uterine-like environment 100% of the time. This correlates with other studies and indicates that limited education, with regard to the NHCU design and an understanding of the effect of the environment, individualised care, positioning and medical procedures, is lacking in staff in the NHCU/NICU, even though they are suggested to be imperative to the health and development of preterm infants (Anderson, 1986; Aucott, et al., 2002; Feldman & Eidelman, 2003; Lubbe, 2008). Categories or subcategories, such as Noise reduction and Handling of the infant, did meet some of the criteria of NDSC. The onus was also on the MDT team, which included the doctors, nursing staff, speech therapists, physiotherapists and occupational therapists, to educate the parents/caregivers on the care of preterm infants and the infant’s development (Nair, et al., 2003). This was limited in the NHCU, especially in terms of behavioural cues when caring for preterm infants. Many studies have shown that when caregivers are empowered by staff, they may be adequate in the physical care of the infant, as was seen in the Family-Centred Care category in the current study: Caring for preterm infants (Ashbaugh, et al., 1999; Flanagan, et al., 2019; Lubbe, 2009).

Twenty-two infants returned for a follow up appointment by the paediatric doctors and allied health professionals' team. The Sensory Profile™ 2 was administered 4 weeks post discharge. All the infants who partook in this stage of the research were monitored; the researcher provided the parents/caregivers with information to assist them with how to manage behaviour with regards to sensory overload, for example, excess screaming, avoiding feeding or reduced appetite. The infants were further monitored and given a home programme after the 3-6 months assessment for those with dysfunction, and monitored on a monthly basis if deemed necessary.

Demographic factors of the infant participants were analysed to understand the impact that these medical and environmental factors would have on sensory modulation. The demographics gathered in this research, matched most of the South African sample size statistics and are therefore congruent with South African premature infant statistics, such as those reported by Mackay et al., (2011), where approximately 43% of infants admitted to the NICU in Johannesburg were included in research on their first follow-up visit (World Health Organization, 2018).

No association, except for a low correlation for head circumference, was found with regard to demographics and sensory modulation. Head circumference differences are a typical characteristic of preterm infants, which has been previously related to sensory modulation. This demographic factor is associated with the infant being born earlier and being more immature, and therefore possibly more susceptible to adverse sensory input outside the womb as well as white (and grey) matter brain abnormalities associated with sensory modulation problems in preterm infants (Rahkonen, et al., 2015). According to the literature, most infants born premature do not have major developmental problems, however, those with lengthy stays in the Neonatal Intensive Care Unit are at risk for sensory modulation problems and developmental sequelae (Case-Smith & O'Brien, 2013; Lubbe, 2008).

Of the participants in the study, 59% were found to be at risk of SMD, having sensory profiles indicating SMD, which was *much more than others* indicating over responsivity and 5% presented with modulation that was *more than others*, also indicating SMD. Only 9% of infants possibly having SMD were found to be under responsive according to their sensory profiles. The quadrant scores for the sensory profile indicated that for the total group at 4 weeks post discharge, sensitivity behaviour was frequently reported for 20% of the infants related to the sensitivity quadrant with a low threshold and passive self-regulation, while more than one third presented with avoiding behaviour frequently, indicating a low sensory threshold and active self-regulation. Seeking behaviour, indicating a high threshold and active self-regulation, occurred only in 10% of the infants. Behaviour in quadrants registration and seeking, associated with a high threshold and under responsivity, was seen less often. Research shows and supports that over stimulation, which may be associated with visual over responsivity due to lights, could result in sensitivity behaviour to stimuli (Fielder & Moseley, 2000). Infants in the NHCU are also subjected to necessary aversive procedures, such as needle sticks and nasogastric intubation (Als & McAnulty, 2011; Stevens, et al., 2014), which can lead to behavioural stress, and touch over responsivity (Als & McAnulty, 2011), resulting in the infants almost never seeking behavioural touch and needing to be swaddled (Als & McAnulty, 2011).

The 10 infants who returned at 3-6 months (corrected age) for their follow up appointments were reassessed with the Bayley-III and ISP 2. All of the infants presented with increased risks of sensory modulation disorders, with 70% of them having a *much more than others* score. which indicated a definite over responsivity. This information suggests that the infants who were more likely to present with SMD returned and they still had difficulty modulating sensory information. (Adams, et al., 2015; Bart, et al., 2011).

When comparing the infants' sensory profiles at 4 weeks post discharge and at 3-6 months (corrected age), a higher percentage of infants (50%) at 3-6 months (corrected age) used the sensory regulation style of avoiding.

The Bayley-III was used to assess the infant's development across five domains at 3-6 months (corrected age). With regards to the Cognition Scale, 40% of participants had severe delay, 10% had moderate delay and 20% had mild delay. These findings were supported by results of a study that indicated that length of stay in the NICU was linked with cognitive scores on the Bayley-III (Courchia, et al., 2019; Ross & Perlman, 2019).

The Language Scale showed 60% of the infants had a moderate delay in expressive communication and 40% had a moderate delay in receptive communication. The composite scores, however, indicated that 100% of the infants (n=10) had a delay in their language. With regard to the Motor Scale (Fine and Gross Motor), for fine motor skills 50% of the participant scores indicated a severe dysfunction and 10% indicated a moderate dysfunction while 100% of the infants presented with severe, moderate or mild gross motor delay. Other studies have also reported higher rates of moderate to severe motor delays, which support the results of this study (Anderson, et al., 2010; Hintz, et al., 2005).

The Social-Emotional Scale and the Adaptive Behaviour Scale were self-report questionnaires and completed by the parent/caregiver. With regard to social-emotional skills, infants who did return for follow up demonstrated only 30% had a moderate delay or problems in socially engaging within their home environment. Adaptive behaviour indicates participants in the group who did return for follow up demonstrated 50% falling within the typical age range of development with regard to their conceptual behaviour (communication and self-direction) and motor behaviour. The composite score for the Adaptive Behaviour Scale indicates 70% within the typical or above the normal age development which may be due to parent’s bias when filling out the adaptive questionnaire. Research shows that preterm infants continue to have clinically significant problems with socio-emotional and adaptive functioning that persists throughout childhood and results in disproportionately high rates of impairment leading to the need for special education placement (Greene, et al., 2013).

No trend could be found for the scores on the ISP 2 and the Bayley-lll when the scores for each infant were compared for developmental delay in infants with SMD. All the infants, however, presented with risk for SMD (*much more than, more than and less than others*) as well as developmental delay.

Research indicates the environment can have an impact on the development of a preterm infant (and the sensory modulation). In this study it was clear that the NHCU environment did not adhere to NDSC principles and a uterine-like atmosphere was not created to support the development of these preterm infants. The use of standardised assessments for the allied health professionals is recommended to ensure that developmental deficits in areas such as sensory modulation, Cognition, Language (receptive and expressive), Motor (gross & fine), Social-Emotional and Adaptive areas are not over looked. Overall, screening and identification of SMD early in a preterm infant's life, allowing for early intervention of at-risk infants and preventing the requirement for longer periods of therapy later in the infant's life, is vital.

6.2 Recommendations

According to the findings of this study, the following recommendations are made:

- This study should be replicated with a larger sample size. The sample size should ideally include tertiary hospitals, and more research sites to compare their data.
- It is recommended that further research regarding the NHCU and premature infants on the development of sensory integration is needed.
- With a larger scale study, potential to investigate the effectiveness of therapeutic intervention provided to these infants will be possible.
- It is important for fellow health care professionals to document history taking, assessment and treatment/management methodically. The use of standardised record keeping system to ensure consistency would be most beneficial. This will ensure that all information is available for all health care professionals to guarantee the best practice.
- Early intervention in the NICU/NHCU is recommended such as stimulation with controlled auditory, tactile, vestibular and multimodal stimulation which could result in improved developmental results.

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APPENDIX A Demographic Questionnaire

Demographic Questionnaire

Dear Parents/ Primary Caregivers,

Please fill in the following questions listed below for the study:

"ENVIRONMENTAL FACTORS, SENSORY MODULATION AND DEVELOPMENT OF PRETERM INFANTS IN THE NEONATAL HIGH CARE UNIT".

1. What is your highest level of education?

   ____

2. What is your child's date of birth?

   ____

3. Please list your telephone number?

   ____

4. Were there any complications when baby was born? If yes, please explain:

   ____

   ____

   ____

   ____

5. How many weeks pregnant was mom, when baby was born?

   ____

APPENDIX B Medical Questionnaire

To be answered by the Occupational Therapist

Date of assessment: ___________________________

1. Birth weight ___________________________
2. Apgar score at 5 minutes ___________________________
3. Days/weeks spend in the Neonatal High Care Unit at Edenvale General Hospital ___________________________
4. Heart rate ___________________________
5. Respiratory effort ___________________________
6. Muscle tone ___________________________
7. Reflex or irritability ___________________________
8. Colour ___________________________
9. Measurements (head circumference; abdominal circumference; length) ___________________________

APPENDIX C Implementation of Neurodevelopmental Supportive Care Checklist

Implementation of Neurodevelopmental Supportive Care : Audit tool (INDeSCa)

Evaluation of the implementation of the principles of NDSC is based on relevancy

Scoring		Score of 4: *All* the criteria for a certain item is met and it is deemed to be *highly relevant* to the criteria. Score of 3: *Most* of the requirements are met, but there are room for improvement and it is *quite relevant*. Score of 2: *Very little* criteria is met and it is *somewhat relevant*. Score of 1: *No* criteria is relevant and the item is *not relevant*.			If scoring is less than 4, please comment to why item is less relevant and recommend any possible changes to make it more relevant.			
Principle	**No**	**Guideline**	**Measurement Criteria**	**4**	**3**	**2**	**1**	**Comment**
6. Environmental manipulation	6.1	**Reduction of noise:** Observe the sound of the ambient environment. Noise levels should not exceed 45dB, with a maximum transient sound not exceeding 70dB. Observe for active intervention to reduce noise levels in all areas of the unit and measurement of noise e.g. "sound ear" or other devices.	No radio or stereo equipment used in the unit, telephones away and rings softly.					
			Doors and drawers are padded to reduce noise					
			Bottoms of trash cans are padded/lids with peddle bins padded					
			Sound levels are measured and kept below 45dB					
			Soft music is used where appropriate.					
			Infant beds are placed away from traffic					
			There are effective sound absorption in infant spaces e.g. curtains, wall hangings or padding.					
			Monitor alarms are kept at a safe minimum volume or set to vibrate/flashing					
			Staff respond to alarms quickly					
		Immediate infant environment: The infant space is not noisy, sound reduction equipment is used with minimal noise around the infant.	Noise reduction incubator covers are used.					
			Soft ear plugs or covers are used.					
			Closed incubator portholes are closed quietly by using the latch					
			Sound levels are measured in the incubator					
			Ventilator tubes are emptied regularly, no water build-up					
			Minimal background noise at the infant					
		Staff generated noise kept to a minimum: No tapping or banging on top of closed incubators, no stock items or documents placed on top of incubators and no loud discussions next to the infants.	Charts and stock items are placed next to incubators, not on top.					
			Staff keep their voices down and away from the infant's bedside					
	6.2	**Reduction of light: Ambient light** is reduced to less than 100 foot-candles (1076 lux). Observe the unit for light reducing strategies and general brightness. Activities are kept low to prevent the need for bright light.	Ambient light is reduced/dimmed					
			Blinds are closed during daylight hours					
			Activity levels are kept as low as possible					
		Immediate infant bed space: Light reduction strategies are in place to protect the infant from direct bright light.	Incubator covers are used with closed incubators					
			Direct bright light is avoided					
			Bedside lights are titrated/controlled					
			Light levels inside incubators are measured					
			Eye protection is used with phototherapy					
			One source of daylight is used with a shading device					
			Overhead lights are dimmed					
			Procedures are kept to a minimum to ensure minimum handling					
			Toys, pictures and appropriate music used to reduce sensory monotony					
		Cycled light: Cycled light are provided from 32 weeks or when the infant begins to differentiate sleep and wake cycles. Observe if there are quiet times scheduled for at least 2 hours in the day, and a 12 hour sleep period at night with low voices and limited activities.	The unit provides cycled light					
			Day/night cycle is provided with 12 hours of low light and sound at night					
	6.3	**Olfactory stimulation:** positive smells are provided. Observe smell of cleaning materials, hand disinfectants etc.	Positive olfactory stimulation is provided, such as mom's smell inside the incubator.					
7. Pain management	7	Observe for the use of non-pharmaceutical pain reduction strategies such as oral sucrose, non-nutritive sucking, swaddling and containment. Check for appropriate use of sucrose at the correct dose and route.	Oral glucose is effectively and correctly administered as pain management option					
			Non-nutritive sucking is provided during painful minor procedures					
8. Knowledge of infant development	8.1	**Staff:** All professionals should have accurate knowledge of the development of preterm infant development in the NICU. Ask for proof of training regarding NDSC attended by staff working in NICU. Collaboration between all health care professionals in the NICU is evident with knowledge sharing sessions.	Staff attended traing and are able to read infant cues and behaviours					
			Knowledge is shared between professionals					
			The unit applies a multidisciplinary team approach					
	8.2	**Parental education:** Parents should be taught the stress cues of their infants. Information are shared with parents, could be verbal, hand-outs, training sessions etc.	Parents are taught preterm infant behavioural cues and stress signs.					
			Parents are taught how to interact with their preterm infant based on the cues and behaviours.					
9. Feeding	9	Observe if infants are prepared for feeding by wrapping and positioning net inside the incubator in a manner that will decrease the need for repositioning after the feed. (gavage feeds) Reduce light and noise during oral feeding, the infant is crades in arms with face approximately 20cm away from the caregiver to provide containment and visual stimulation.	Preterm infants are prepared for feeding.					
			Preterm infants are positioned in a way that prevents the need for repositioning after a gavage feed.					
			Non-nutritive sucking is provided during gavage feeding.					

Implementation of Neurodevelopmental Supportive Care : Audit tool (INDeSCa)

Evaluation of the implementation of the principles of NDSC is based on relevancy

Scoring		Score of 4: *All* the criteria for a certain item is met and it is deemed to be *highly relevant* to the criteria. Score of 3: *Most* of the requirements are met, but there are room for improvement and it is *quite relevant*. Score of 2: *Very little* criteria is met and it is *somewhat relevant*. Score of 1: *No* criteria is relevant and the item is *not relevent*.						If scoring is less than 4, please comment to why item is less relevant and recommend any possible changes to make it more relevant.
Principle	**No**	**Guideline**	**Measurement Criteria**	**4**	**3**	**2**	**1**	**Comment**
5. Handling Techniques (transition support)	5.1	**Care according to maturation:** Caregiving interventions by healthcare providers should be adapted according to the preterm infant's gestational age, adaptation and maturation. Observe caring and handling to ensure all infants are not managed the same despite differences in age and maturation.	Care changes as infants matures.					
	5.2	**State changes:** Observe if infants are prepared before procedures, infants are aroused gently using mild stimuli initially that gradually increases as the infants respond. The infants are assisted to reach a calm and regulated state before beginning an intervention.	The care giver supports gradual state changes by using transitional touch.					
	5.3	**Promotion of rest and sleep:** Check if infants are asleep between routine cares for 2-3 hours at a time, consult the patient record for notes on interventions performed. Check if the unit has scheduled quiet times or rest periods where all routine care is delayed.	The infants receive at least 2-3 hours uninterrupted sleep					
			The unit has quiet times where all routine cares and interventions are delayed.					
	5.4	**Modified hands-on care-giving:** Hands-on care is provided as the infant becomes more alert, rather than interrupting sleep. Check nursing notes for entries such as "minimal handling' where routine care is delayed, or if notes are attached to the infant bed/incubator indicating minimal care. Containment is provided after intervention to help infants transition to a sleep state. Observe care during handling if time out periods are provided to the infant based on correct interpretation of stress cues. Opportunities are provided to suck on a finger or pacifier, and gentle touch provided as positive tactile stimulation to calm the infant.	Care interventions are clustered around sleep.					
			Calm, gentle containment and facilitation is provided during handling procedures to support flexion.					
			The infant is provided with "time-out" or rest periods according to his/her cues					
			Direct hands-on-caregiving is modified by providing positive tactile stimulation.					
	5.5	**Positive tactile stimulation:** Still holding or containment hold incorporates cupping the infant's head or resting a still hand on the body. Gentle massage can be provided, but light stroking avoided. Skin -to-skin care is provided. Infants are swaddled if applicable, with tight wrapping in a blanket with the limbs flexed, hips neutral without rotation, shoulders forward, head neutral and hands accessible for exploration of the face.	Positive tactile stimulation is provided, including stroking or gentle massage if applicable.					
			Containment or still hold is provided.					
			Parents are allowed to do skin-to skin care with their infants within 24-48 hours (2), after 48 hours (1) never or no proof of skin-to-skin (0)					
			Preterm infants are swaddled.					
	5.6	**Movement (Kinaesthetic stimulation)** Observe movement of infants, no abrupt stimulation or quick turning takes place. Infants are moved slowly. Appropriate bedding is used that does not provide overstimulation of the vestibular system, waterbeds are not used, and knotted sheepskin is not in the beds. Multiples are co-bedded as they direct motor-activities at their siblings.	Preterm infants are moved slowly, as a whole, keeping the body and head aligned and limbs tucked in.					
			Appropriate soft bedding is used					
			Multiples are co-bedded. Always (2) if stable (1) never (0)					
	5.7	**Self-regulation:** Self regulation is promoted by providing support before, during, and after routine cares. Observe if the infant is provided with opportunities for grasping like fingers or bedding. State regulation is promoted by gentle touch and decreasing stimulation and non-nutritive sucking is provided with appropriate pacifier.	Self-regulation of infants are promoted.					
			Infants are provided with opportunities for grasping.					
			State regulation is promoted.					
			Non-nutritive sucking is provided to support self-regulation					

Implementation of Neurodevelopmental Supportive Care : Audit tool (INDeSCa)

Evaluation of the implementation of the principles of NDSC is based on relevancy

Scoring		Score of 4: *All* the criteria for a certain item is met and it is deemed to be *highly relevant* to the criteria. Score of 3: *Most* of the requirements are met, but there are room for improvement and it is *quite relevant*. Score of 2: *Very little* criteria is met and it is *somewhat relevant*. Score of 1: *No* criteria is relevant and the item is *not relevant*.		If scoring is less than 4, please comment to why item is less relevant and recommend any possible changes to make it more relevant.				
Principle	**No**	**Guideline**	**Measurement Criteria**	4	3	2	1	**Comment**
1. NICU Design	1	First impression on entering the NICU. Does the unit overall create a quiet, dim, warm, impression. Lights should be dimmed, individual incubators shielded or covered. Low ambient noise. Minimal activity in general, with infant spaces away from traffic.	Is a uterine-like environment created for each infant to support and environment conducive to growth and optimum development					
2. Individualised care	2.1	**Observation:** Observe the interaction between caregivers and infants. Interventions should be relevant to the infant's gestational age, adaptations to interventions and infant's cues and behaviours communicated during interventions.	The caregiver reads the infant's cues and behaviours					
			The staff responds to infant cues and behaviours					
			The caregiver continuously and systematically assess and evaluate the infant's developmental needs					
			Care is adapted according to cues and behaviours.					
	2.2	**Care:** Staff should individualise their caregiving interventions, including acting on the infant's cues. Individualised interventions respect the individuality of the infant. Appropriate actions include engaging in eye contact, gentle touch, and respectful communication.	Care is provided according to the infant's individual developmental maturity					
			Autonomic, motoric, and behavioural cues are identified and used to support individualised caregiving.					
3. Family centred philosophy	3.1	**Parents as active participants:** Family centeredness emphasises the individuality of the infant, and reduces maternal stress with increased self-esteem of the parent. Observe parent involvement and interaction with their infant. Check patient notes for entries related to parent visits and interactions. Discharge training starts on admission (2), when stable (1), just before discharge (0)	Parents see their infant immediately after birth					
			Parents touch their infant immediately after birth					
			Parents hold their infant					
			Parents are involved with care, e.g. feeding, bath, KMC.					
			Parents are allowed to personalise their infant's bed space					
			Mother's are encouraged to express milk for their infant, or to breastfeed.					
			Discharge training commenced					
	3.2	**Privacy and comfort:** The NICU should provide a warm homelike atmosphere where parents feel welcome, that promotes information sharing between professionals and parents, and parents privacy are respected and catered for. Information is supplied to patents that is relevant to their infant's developmental needs, not generic but tailored to their infant's gestational age, development and clinical condition.	Nursery atmosphere is warm, comfortable and soothing with a homelike appearance					
			Privacy is provided for parents					
			Information is shared between professionals and parents regarding their infant's developmental needs.					
	3.3	**Visitation:** Family cantered care is provided by 24 hour visitation policy for parents, and sibling visitation is encouraged. When parents are allowed any time of the day, (2), If there are times they are excluded e.g. handover or quiet times (1) if parents are required to leave the unit for more than 3 hours a day (0)	Parents are allowed to visit at any time					
			Siblings may visit					
	3.4	**Parent support groups:** Family support is provided as parent support groups. If the facility provide support groups for preemie care (2) If Parents are referred to external support groups (1), if none is available or referred to (0)	The facility has parent support groups					
4. Positioning	4.1	**Anatomical infant positioning:** Anatomical positioning means that the preterm infant is positioned with the neck in a neutral position, shoulders protracted, body symmetric, knees flexed with hips and arms in midline. This state is reached with the use of containment and firm boundaries. If all of the infants in the unit are positioned correctly (2) more than 50% infants positioned correctly (1) less than 50% positioned correctly (0)	Infants are positioned anatomically with the neck in a neutral position, shoulders protracted, body symmetric, knees flexed with hips and arms in midline. This state is reached with the use of containment and firm boundaries.					
		Containment: The infants are contained with the use of individualised bedding and positioning tools to contain the infant in flexion and the hips neutral.	The infants are contained					
			The infants have firm boundaries that fit snugly					
		Midline: The head should be positioned in midline and in line with the body - especially in acutely ill infants to promote hands to face.	The body position is symmetric					
			The neck is in neutral position with the head in midline in line with the body.					
			The shoulders are protracted					
			The arms are in midline.					
		Flexion: Limbs and shoulders should be flexed (bent) during positioning with postural support using firm boundaries.	The knees are flexed					
			The hips are flexed in a neutral position with some adduction					
			Infant is kept in flexion (limbs and shoulders) during positioning and postural support.					
	4.2	**Orientation:** Prone or side-lying positions should be used rather than the supine position. Evaluate the infants in the unit, if more than 75% of infants are prone or side lying (2) if about 50% of infants are supine (1) more than 50% positioned supine (0)	Prone or side-lying positions are rather used than supine, especially in acutely ill infants					
	4.3	**Individualised bedding:** Individualised bedding and support is used such as blanket rolls, support wedges, stuffed toys, nappies or loose swaddling that provides gentle pressure for bracing, but flexible enough to allow movement.	Individualised bedding is used to position infants.					

APPENDIX D Infant Sensory Profile™ 2

INFANT SENSORY PROFILE 2

Winnie Dunn, PhD, OTR, FAOTA

Caregiver Questionnaire

Birth to 6 months

FOR OFFICE USE ONLY			
Calculation of Child's Age			
	Year	Month	Day
Test Date			
Birth Date			
Age			

Child's First Name: ____________ Child's Middle Name: ____________

Child's Last Name: ____________ ID Number: ____________

Child's Preferred Name (if different from above): ____________

Gender: ☐Male ☐Female Birth Date: ___/___/___ Test Date: ___/___/___

Examiner/Service Provider's Name: ____________

Examiner/Service Provider's Profession: ____________

Completed by/Caregiver's Name: ____________

Caregiver's Relationship to Child: ____________

Name of Daycare Center: ____________

Was this child born prematurely? ☐Yes ☐No If yes, by how many weeks? ____________

In what order was your child born in relation to siblings (for example, 1st child, 3rd child, etc.)?
☐Only Child ☐1st ☐2nd ☐3rd ☐4th ☐5th ☐Other____________

Have there been more than three children between the ages of birth through 18 years living in your household during the past 12 months? ☐Yes ☐No

INSTRUCTIONS

The pages that follow contain statements that describe how babies may act. Please read each phrase and select the option that best describes how often your baby shows these behaviors. *Please mark one option for every statement.*
Use these guidelines to mark your responses:

When presented with the opportunity, my baby...

Almost Always	responds in this manner **Almost Always** (90% or more of the time).
Frequently	responds in this manner **Frequently** (75% of the time).
Half the Time	responds in this manner **Half the Time** (50% of the time).
Occasionally	responds in this manner **Occasionally** (25% of the time).
Almost Never	responds in this manner **Almost Never** (10% or less of the time).
Does Not Apply	If you are unable to answer because you have not observed the behavior or believe that it does not apply to your baby, please check **Does Not Apply**.

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Almost Always = 90% or more	Frequently = 75%	Half the Time = 50%	Occasionally = 25%	Almost Never = 10% or less

GENERAL Processing

Quadrant	Item	My baby...	Almost Always 5	Frequently 4	Half the Time 3	Occasionally 2	Almost Never 1	Does Not Apply
RG	1	stays quiet and calm in an active setting compared to other babies.						
RG	2	is unaware of people coming in or leaving the room.						
SN	3	needs the same routine to stay content and calm.						
	4	acts in a way that interferes with family schedules and plans.						
SN	5	requires help to get to sleep.						
SN	6	is irritable compared to other babies.						
	7	sleeps more than other babies.						
RG	8	only pays attention when I touch my baby (and hearing is OK).						

GENERAL Raw Score

GENERAL Processing Comments: ______

AUDITORY Processing

Quadrant	Item	My baby...	Almost Always 5	Frequently 4	Half the Time 3	Occasionally 2	Almost Never 1	Does Not Apply
SK	9	enjoys making mouth sounds (for example, blowing raspberries, making noises with lips, humming).						
	10	ignores me when I am talking.						
	11	becomes upset by sudden everyday sounds.						
SK	12	becomes more animated and engaged around music, talking, or sound toys.						

AUDITORY Raw Score

AUDITORY Processing Comments: ______

VISUAL Processing

Quadrant	Item	My baby...	Almost Always 5	Frequently 4	Half the Time 3	Occasionally 2	Almost Never 1	Does Not Apply
AV	13	misses eye contact with me during everyday interactions.						
AV	14	looks away from toys or faces.						
AV	15	looks away or becomes restless in noisy settings or with noisy toys.						
SN	16	blinks a lot when objects or people come close to face.						

VISUAL Raw Score

VISUAL Processing Comments: ______

Almost Always = 90% or more	Frequently = 75%	Half the Time = 50%	Occasionally = 25%	Almost Never = 10% or less

TOUCH Processing

Quadrant	Item	My baby...	Almost Always 5	Frequently 4	Half the Time 3	Occasionally 2	Almost Never 1
	17	becomes upset when having nails trimmed.					
SN	18	needs to be swaddled or wrapped to relax.					
SN	19	is startled by texture differences (for example, on grass, on carpet, on blankets).					

TOUCH Raw Score

TOUCH Processing Comments: ______________________

MOVEMENT Processing

Quadrant	Item	My baby...	Almost Always 5	Frequently 4	Half the Time 3	Occasionally 2	Almost Never 1
SK	20	enjoys rhythmical activities (for example, swinging, rocking, car rides).					
AV	21	resists having head tipped back during bathing.					
	22	cries or fusses with everyday movement.					
RG	23	needs more head support when being held compared to other babies.					

MOVEMENT Raw Score

MOVEMENT Processing Comments: ______________________

ORAL SENSORY Processing

Quadrant	Item	My baby...	Almost Always 5	Frequently 4	Half the Time 3	Occasionally 2	Almost Never 1
	24	struggles to close mouth when feeding from the breast or bottle (for example, doesn't latch on).					
SK	25	enjoys making movements or sounds with mouth.					

ORAL SENSORY Raw Score

ORAL SENSORY Processing Comments: ______________________

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ICON KEY	
SK	Seeking
AV	Avoiding
SN	Sensitivity
RG	Registration
	No Quadrant

SCORE KEY	
5	Almost Always = 90% or more
4	Frequently = 75%
3	Half the Time = 50%
2	Occasionally = 25%
1	Almost Never = 10% or less

FOR OFFICE USE ONLY

INFANT SENSORY PROFILE 2

SCORE SUMMARY

Instructions

Please read carefully the detailed hand-scoring instructions in chapter 4 of the Sensory Profile 2 User's Manual. Transfer the item raw score from the Caregiver Questionnaire to the corresponding sections in the table below. Add the raw scores to obtain the Infant Sensory Profile 2 Raw Score Total.

Section	Raw Score
GENERAL Processing	
AUDITORY Processing	
VISUAL Processing	
TOUCH Processing	
MOVEMENT Processing	
ORAL SENSORY Processing	
Infant Sensory Profile 2 Raw Score Total	

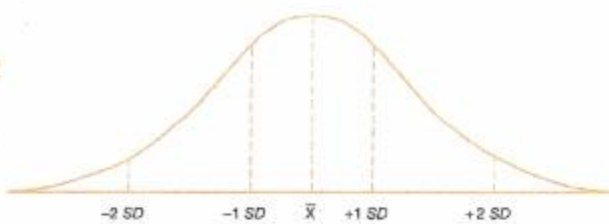
Summary Scores

Instructions

Transfer the Raw Score Total to the corresponding Raw Score Total box. Plot the total by marking an X in the appropriate classification column (e.g., Less Than Others, More Than Others, Just Like the Majority of Others).

The Normal Curve and Sensory Profile 2 Classification System

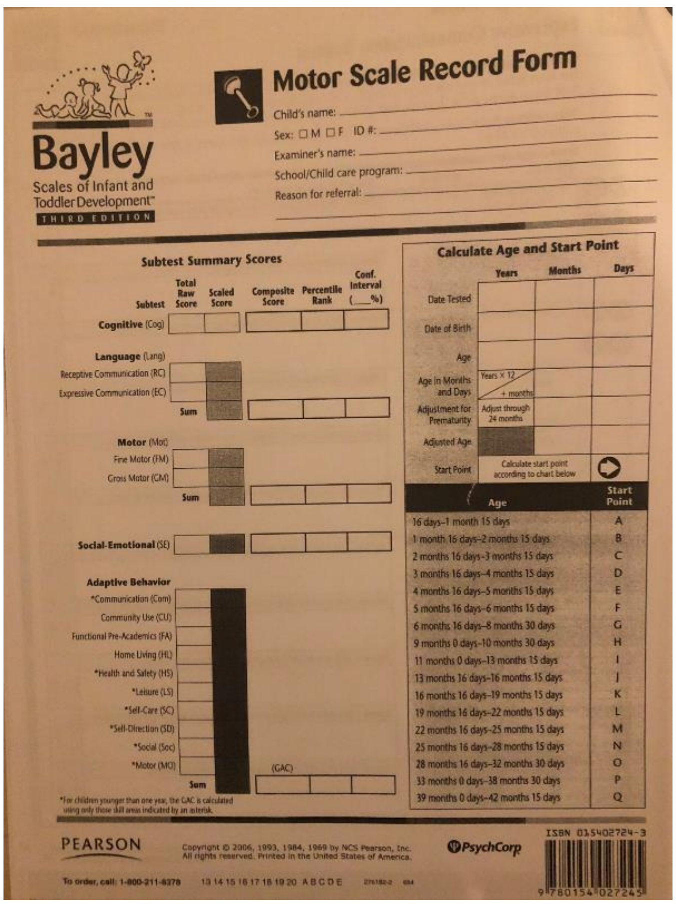
Scores one standard deviation or more from the mean are expressed as More Than Others or Less Than Others, respectively. Scores two standard deviations or more from the mean are expressed as Much More Than Others or Much Less Than Others, respectively.



			◄ Less Than Others			More Than Others ►	
	Raw Score Total	Percentile Range[a]	Much Less Than Others	Less Than Others	Just Like the Majority of Others	More Than Others	Much More Than Others
Infant Total Score	/125		0-------30	31-------40	41-------61	62-------71	72-------125

[a] For percentile ranges, see Appendix A in the Sensory Profile 2 User's Manual.

APPENDIX E Bayley® Scale of Infant Development – 3rd Edition (Bayley-III)



Bayley
Scales of Infant and Toddler Development™
THIRD EDITION

Motor Scale Record Form

Child's name:
Sex: ☐ M ☐ F ID #:
Examiner's name:
School/Child care program:
Reason for referral:

Subtest Summary Scores

Subtest	Total Raw Score	Scaled Score	Composite Score	Percentile Rank	Conf. Interval (___%)
Cognitive (Cog)					
Language (Lang)					
Receptive Communication (RC)					
Expressive Communication (EC)					
Sum					
Motor (Mot)					
Fine Motor (FM)					
Gross Motor (GM)					
Sum					
Social-Emotional (SE)					
Adaptive Behavior					
*Communication (Com)					
Community Use (CU)					
Functional Pre-Academics (FA)					
Home Living (HL)					
*Health and Safety (HS)					
*Leisure (LS)					
*Self-Care (SC)					
*Self-Direction (SD)					
*Social (Soc)					
*Motor (MO)			(GAC)		
Sum					

*For children younger than one year, the GAC is calculated using only those skill areas indicated by an asterisk.

Calculate Age and Start Point

	Years	Months	Days
Date Tested			
Date of Birth			
Age			
Age in Months and Days	Years × 12 + months		
Adjustment for Prematurity	Adjust through 24 months		
Adjusted Age			
Start Point	Calculate start point according to chart below		

Age	Start Point
16 days–1 month 15 days	A
1 month 16 days–2 months 15 days	B
2 months 16 days–3 months 15 days	C
3 months 16 days–4 months 15 days	D
4 months 16 days–5 months 15 days	E
5 months 16 days–6 months 15 days	F
6 months 16 days–8 months 30 days	G
9 months 0 days–10 months 30 days	H
11 months 0 days–13 months 15 days	I
13 months 16 days–16 months 15 days	J
16 months 16 days–19 months 15 days	K
19 months 16 days–22 months 15 days	L
22 months 16 days–25 months 15 days	M
25 months 16 days–28 months 15 days	N
28 months 16 days–32 months 30 days	O
33 months 0 days–38 months 30 days	P
39 months 0 days–42 months 15 days	Q

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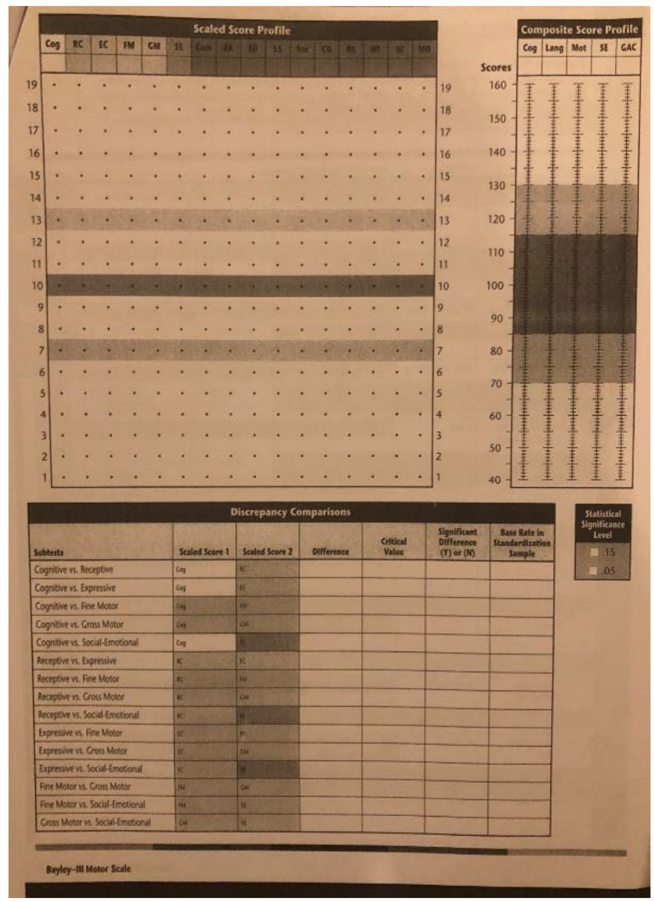


Scaled Score Profile

Cog RC EC FM GM SE Com CU FA HL HS LS SC SD Soc MO

Composite Score Profile

Scores
Cog Lang Mot SE GAC

Discrepancy Comparisons

Subtests	Scaled Score 1	Scaled Score 2	Difference	Critical Value	Significant Difference (Y) or (N)	Base Rate in Standardization Sample
Cognitive vs. Receptive	Cog	RC				
Cognitive vs. Expressive	Cog	EC				
Cognitive vs. Fine Motor	Cog	FM				
Cognitive vs. Gross Motor	Cog	GM				
Cognitive vs. Social-Emotional	Cog	SE				
Receptive vs. Expressive	RC	EC				
Receptive vs. Fine Motor	RC	FM				
Receptive vs. Gross Motor	RC	GM				
Receptive vs. Social-Emotional	RC	SE				
Expressive vs. Fine Motor	EC	FM				
Expressive vs. Gross Motor	EC	GM				
Expressive vs. Social-Emotional	EC	SE				
Fine Motor vs. Gross Motor	FM	GM				
Fine Motor vs. Social-Emotional	FM	SE				
Gross Motor vs. Social-Emotional	GM	SE				

Statistical Significance Level
.15
.05

Bayley-III Motor Scale

Cognitive Scale

Reversal Rule: The child must obtain scores of 1 on the first three consecutive items at the start point of any age to go forward. If the child obtains a score of zero on any of the first three items, go back to the start point for the previous age and administer those items.

Discontinue Rule: Stop administration when the child obtains scores of zero on five consecutive items.

Item	Materials	Score Criteria and Comments	Score
1. Calms When Picked Up	None	**Score:** Child calms when picked up by either you or caregiver.	1 0
2. Responds to Surroundings Series: Inspects	None	**Score:** Child freely turns eyes or head in visual exploration of surroundings.	1 0
3. Regards Object for 3 Seconds	Ring with string, ball, or other small object of interest	**Score:** Child gazes continuously at object for at least 3 seconds.	1 0
4. Habituates to Rattle	Rattle	Trials: 5 **Score:** Child displays orienting response to stimulus, then habituates during any of the remaining trials.	1 0
5. Discriminates Between Objects	Bell Stopwatch 5 seconds	**Score:** Child responds to bell by displaying a marked behavioral change within 5 seconds after you ring bell.	1 0
6. Recognizes Caregiver	None	**Score:** Child's expression changes to indicate recognition of the caregiver.	1 0
7. Becomes Excited in Anticipation	None	**Score:** Child displays anticipatory excitement.	1 0
8. Regards Object for 5 Seconds	Block or other small object of interest Stopwatch 5 seconds	**Score:** Child regards object continuously for at least 5 seconds.	1 0
9. Reacts to Disappearance of Face	None	**Score:** Child changes facial expression or displays other reaction to caregiver's disappearance.	1 0
10. Shifts Attention	Bell Rattle	Trials: 3 **Score:** Child's eyes move from one object to another in response to sound or movement of object(s).	1 0

Bayley–III Cognitive Scale 3

Item	Materials	Score Criteria and Comments	Score
11. Shows Visual Preference	Stimulus Book (pp. 7–9) Stopwatch 15 seconds per page	**Score:** Child looks longer at striped pattern on both pages.	1 0
12. Habituates to Object	2 blocks without holes Stopwatch 30 seconds	**Score:** Child habituates within 30 seconds, displaying decrease in attention and interest.	1 0
13. Prefers Novel Object	Block without hole Small ball Stopwatch 15 seconds per presentation	**Score:** Child looks longer at ball than block in both presentations.	1 0
14. Habituates to Picture (Balloons)	Stimulus Book (p. 11) Stopwatch 30 seconds	**Score:** Child habituates within 30 seconds, displaying decrease in attention and interest.	1 0
15. Prefers Novel Picture (Ball)	Stimulus Book (pp. 13–15) Stopwatch 15 seconds per page	**Score:** Child looks longer at ball than balloons in both presentations.	1 0
16. Explores Object	Rattle or other small object of interest	**Score:** Child attends to sight, sound, or feel of object by shaking, mouthing, or other activity.	1 0
17. Carries Object to Mouth	Glitter bracelet or other small object of interest	**Score:** Child purposely carries object to mouth.	1 0
18. Inspects Own Hand	None	**Score:** Child visually inspects one or both hands.	1 0
19. Mirror Image Series: Approaches	Mirror	**Score:** Child approaches mirror image with head, body, or hands, or purposely touches mirror image.	1 0
20. Responds to Surroundings Series: Awareness of Novelty	None	**Score:** Child displays awareness of being in novel surroundings (e.g., startles, looks around).	1 0
21. Persistent Reach	Block without hole or other small object of interest	**Score:** Child persistently reaches for object, even if he or she fails to obtain it.	1 0

Bayley–III Cognitive Scale

Item	Materials	Score Criteria and Comments	Score
22. Mirror Image Series: Responds Positively	Mirror	**Score:** Child plays with image by looking and smiling/laughing, patting, banging, reaching playfully, or mouthing.	1 0
23. Plays With String	Ring with string	**Score:** Child plays with string by picking it up, chewing it, pulling on it, or manipulating it.	1 0
24. Bangs in Play	Block without hole, spoon, or other suitable hard object	**Score:** Child purposely bangs in play at any time during testing.	1 0
25. Searches for Fallen Object	Squeeze toy	**Score:** Child looks for fallen toy by looking toward floor.	1 0
26. Bell Series: Manipulates	Bell	**Score:** Child manipulates bell while looking at it with interest.	1 0
27. Picks Up Block Series: Reaches for Second Block	3 blocks without holes	**Score:** Child holds first block and reaches for second block.	1 0
28. Pulls Cloth to Obtain Object	Washcloth Object of interest	**Score:** Child pulls washcloth purposely toward him or her to obtain object.	1 0
29. Pulls String Adaptively	Ring with string	**Score:** Child picks up string, purposely pulls to secure ring, and grasps ring.	1 0
30. Retains Both Blocks	2 blocks without holes	**Score:** Child holds both blocks simultaneously for at least 3 seconds.	1 0
31. Bell Series: Rings Purposely	Bell	**Score:** Child holds bell by handle and purposely rings it.	1 0
32. Looks at Pictures	Picture Book	**Score:** Child regards one or more specific pictures with interest or recognition.	1 0
33. Picks Up Block Series: Retains 2 of 3 Blocks	3 blocks without holes	**Score:** Child retains first two blocks for at least 3 seconds after visually attending to third block.	1 0

Bayley–III Cognitive Scale 5

Language Scale

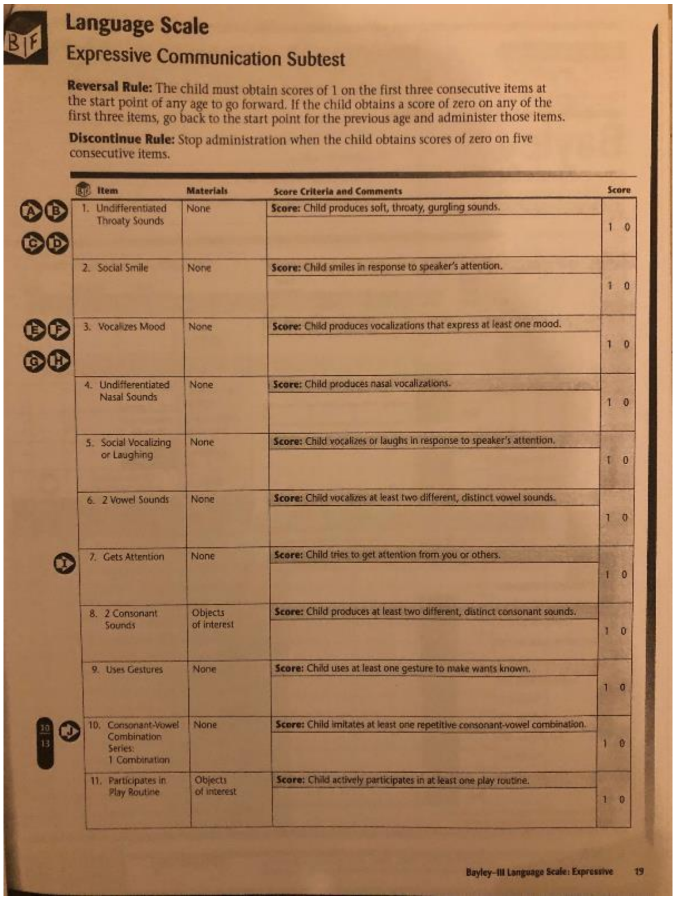
Receptive Communication Subtest

Reversal Rule: The child must obtain scores of 1 on the first three consecutive items at the start point of any age to go forward. If the child obtains a score of zero on any of the first three items, go back to the start point for the previous age and administer those items.

Discontinue Rule: Stop administration when the child obtains scores of zero on five consecutive items.

Item	Materials	Score Criteria and Comments	Score
1. Regards Person Momentarily	None	**Score:** Child fixes gaze on the person for at least 2 seconds.	1 0
2. Tolerates Attention	None	**Score:** Child tolerates attention and does not show signs of distress.	1 0
3. Calms When Spoken To	None	**Score:** Child calms when spoken to.	1 0
4. Reacts to Sounds in the Environment	Squeeze toy	**Score:** Child clearly reacts to the sound presented.	1 0
5. Responds to a Person's Voice	None	**Score:** Child clearly responds to the person's voice.	1 0
6. Searches With Head Turn	Bell Rattle	Trials: 2 **Score:** Child purposely turns head toward source of the sound.	1 0
7. Discriminates Sounds	Paper Rattle	**Score:** Child clearly responds to sound of the rattle.	1 0
8. Sustained Play With Objects	Objects of interest Stopwatch 60 seconds	**Score:** Child interacts with objects for at least 60 seconds.	1 0
9. Responds to Name	None	**Score:** Child turns head both times his or her name is called, but does not respond to unfamiliar name.	1 0
10. Interrupts Activity	Objects of interest	**Score:** Child looks up and briefly pauses during play when you call his or her name.	1 0
11. Recognizes 2 Familiar Words	None	**Score:** Child responds differentially to at least two familiar words.	1 0

Bayley–III Language Scale: Receptive 13



Language Scale

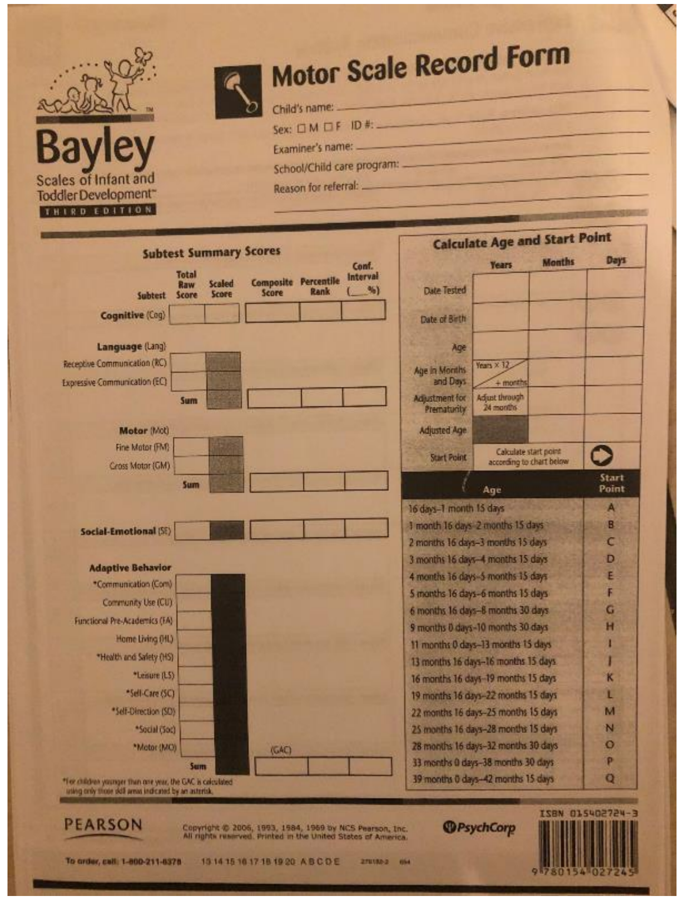
Expressive Communication Subtest

Reversal Rule: The child must obtain scores of 1 on the first three consecutive items at the start point of any age to go forward. If the child obtains a score of zero on any of the first three items, go back to the start point for the previous age and administer those items.

Discontinue Rule: Stop administration when the child obtains scores of zero on five consecutive items.

Start	Item	Materials	Score Criteria and Comments	Score
A B C D	1. Undifferentiated Throaty Sounds	None	**Score:** Child produces soft, throaty, gurgling sounds.	1 0
	2. Social Smile	None	**Score:** Child smiles in response to speaker's attention.	1 0
E F G H	3. Vocalizes Mood	None	**Score:** Child produces vocalizations that express at least one mood.	1 0
	4. Undifferentiated Nasal Sounds	None	**Score:** Child produces nasal vocalizations.	1 0
	5. Social Vocalizing or Laughing	None	**Score:** Child vocalizes or laughs in response to speaker's attention.	1 0
	6. 2 Vowel Sounds	None	**Score:** Child vocalizes at least two different, distinct vowel sounds.	1 0
I	7. Gets Attention	None	**Score:** Child tries to get attention from you or others.	1 0
	8. 2 Consonant Sounds	Objects of interest	**Score:** Child produces at least two different, distinct consonant sounds.	1 0
	9. Uses Gestures	None	**Score:** Child uses at least one gesture to make wants known.	1 0
10 13 J	10. Consonant-Vowel Combination Series: 1 Combination	None	**Score:** Child imitates at least one repetitive consonant-vowel combination.	1 0
	11. Participates in Play Routine	Objects of interest	**Score:** Child actively participates in at least one play routine.	1 0

Bayley–III Language Scale: Expressive 19



Bayley Scales of Infant and Toddler Development™ THIRD EDITION

Motor Scale Record Form

Child's name: ________
Sex: ☐ M ☐ F ID #: ________
Examiner's name: ________
School/Child care program: ________
Reason for referral: ________

Subtest Summary Scores

Subtest	Total Raw Score	Scaled Score	Composite Score	Percentile Rank	Conf. Interval (__%)
Cognitive (Cog)					
Language (Lang)					
Receptive Communication (RC)					
Expressive Communication (EC)					
Sum					
Motor (Mot)					
Fine Motor (FM)					
Gross Motor (GM)					
Sum					
Social-Emotional (SE)					
Adaptive Behavior					
*Communication (Com)					
Community Use (CU)					
Functional Pre-Academics (FA)					
Home Living (HL)					
*Health and Safety (HS)					
*Leisure (LS)					
*Self-Care (SC)					
*Self-Direction (SD)					
*Social (Soc)					
*Motor (MO)					
Sum			(GAC)		

*For children younger than one year, the GAC is calculated using only those skill areas indicated by an asterisk.

Calculate Age and Start Point

	Years	Months	Days
Date Tested			
Date of Birth			
Age			
Age in Months and Days	Years × 12 + months		
Adjustment for Prematurity	Adjust through 24 months		
Adjusted Age			
Start Point	Calculate start point according to chart below		

Age	Start Point
16 days–1 month 15 days	A
1 month 16 days–2 months 15 days	B
2 months 16 days–3 months 15 days	C
3 months 16 days–4 months 15 days	D
4 months 16 days–5 months 15 days	E
5 months 16 days–6 months 15 days	F
6 months 16 days–8 months 30 days	G
9 months 0 days–10 months 30 days	H
11 months 0 days–13 months 15 days	I
13 months 16 days–16 months 15 days	J
16 months 16 days–19 months 15 days	K
19 months 16 days–22 months 15 days	L
22 months 16 days–25 months 15 days	M
25 months 16 days–28 months 15 days	N
28 months 16 days–32 months 30 days	O
33 months 0 days–38 months 30 days	P
39 months 0 days–42 months 15 days	Q

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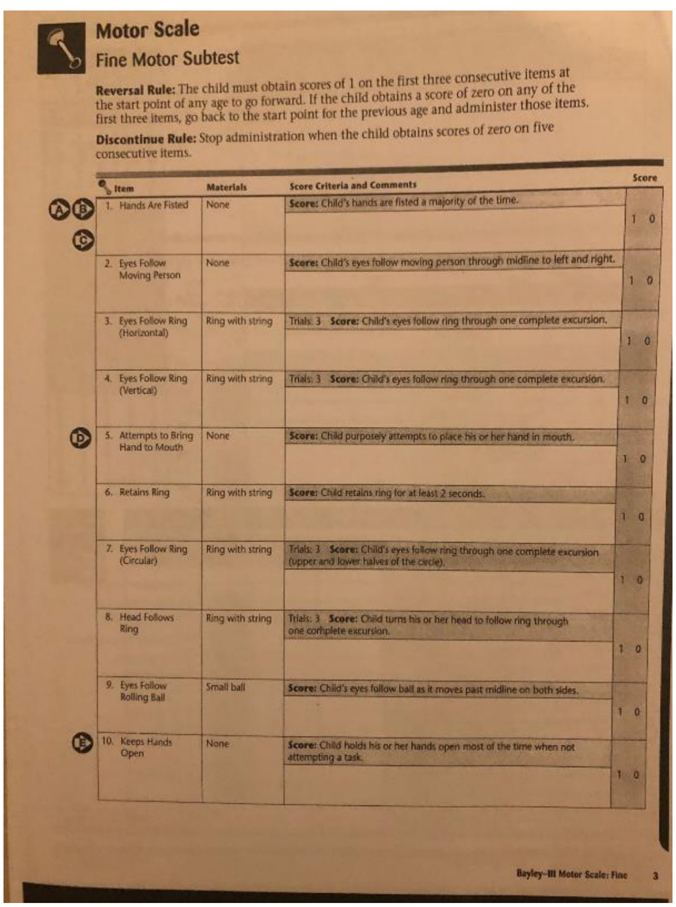


Motor Scale

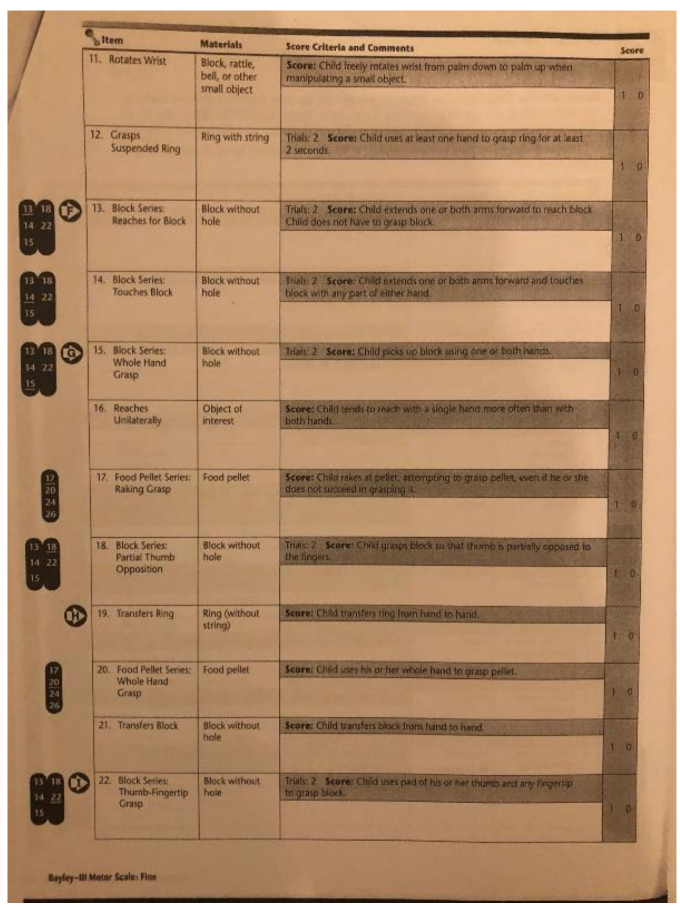
Fine Motor Subtest

Reversal Rule: The child must obtain scores of 1 on the first three consecutive items at the start point of any age to go forward. If the child obtains a score of zero on any of the first three items, go back to the start point for the previous age and administer those items.

Discontinue Rule: Stop administration when the child obtains scores of zero on five consecutive items.

Start	Item	Materials	Score Criteria and Comments	Score
A B C	1. Hands Are Fisted	None	**Score:** Child's hands are fisted a majority of the time.	1 0
	2. Eyes Follow Moving Person	None	**Score:** Child's eyes follow moving person through midline to left and right.	1 0
	3. Eyes Follow Ring (Horizontal)	Ring with string	Trials: 3 **Score:** Child's eyes follow ring through one complete excursion.	1 0
	4. Eyes Follow Ring (Vertical)	Ring with string	Trials: 3 **Score:** Child's eyes follow ring through one complete excursion.	1 0
D	5. Attempts to Bring Hand to Mouth	None	**Score:** Child purposely attempts to place his or her hand in mouth.	1 0
	6. Retains Ring	Ring with string	**Score:** Child retains ring for at least 2 seconds.	1 0
	7. Eyes Follow Ring (Circular)	Ring with string	Trials: 3 **Score:** Child's eyes follow ring through one complete excursion (upper and lower halves of the circle).	1 0
	8. Head Follows Ring	Ring with string	Trials: 3 **Score:** Child turns his or her head to follow ring through one complete excursion.	1 0
	9. Eyes Follow Rolling Ball	Small ball	**Score:** Child's eyes follow ball as it moves past midline on both sides.	1 0
E	10. Keeps Hands Open	None	**Score:** Child holds his or her hands open most of the time when not attempting a task.	1 0

Bayley–III Motor Scale: Fine 3



Start	Item	Materials	Score Criteria and Comments	Score
	11. Rotates Wrist	Block, rattle, bell, or other small object	**Score:** Child freely rotates wrist from palm down to palm up when manipulating a small object.	1 0
	12. Grasps Suspended Ring	Ring with string	Trials: 2 **Score:** Child uses at least one hand to grasp ring for at least 2 seconds.	1 0
13 18 14 22 15 F	13. Block Series: Reaches for Block	Block without hole	Trials: 2 **Score:** Child extends one or both arms forward to reach block. Child does not have to grasp block.	1 0
13 18 14 22 15	14. Block Series: Touches Block	Block without hole	Trials: 2 **Score:** Child extends one or both arms forward and touches block with any part of either hand.	1 0
13 18 14 22 15 G	15. Block Series: Whole Hand Grasp	Block without hole	Trials: 2 **Score:** Child picks up block using one or both hands.	1 0
	16. Reaches Unilaterally	Object of interest	**Score:** Child tends to reach with a single hand more often than with both hands.	1 0
17 20 24 26	17. Food Pellet Series: Raking Grasp	Food pellet	**Score:** Child rakes at pellet, attempting to grasp pellet, even if he or she does not succeed in grasping it.	1 0
13 18 14 22 15	18. Block Series: Partial Thumb Opposition	Block without hole	Trials: 2 **Score:** Child grasps block so that thumb is partially opposed to the fingers.	1 0
H	19. Transfers Ring	Ring (without string)	**Score:** Child transfers ring from hand to hand.	1 0
17 20 24 26	20. Food Pellet Series: Whole Hand Grasp	Food pellet	**Score:** Child uses his or her whole hand to grasp pellet.	1 0
	21. Transfers Block	Block without hole	**Score:** Child transfers block from hand to hand.	1 0
13 18 14 22 15 I	22. Block Series: Thumb-Fingertip Grasp	Block without hole	Trials: 2 **Score:** Child uses pad of his or her thumb and any fingertip to grasp block.	1 0

Bayley–III Motor Scale: Fine

Motor Scale

Gross Motor Subtest

Reversal Rule: The child must obtain scores of 1 on the first three consecutive items at the start point of any age to go forward. If the child obtains a score of zero on any of the first three items, go back to the start point for the previous age and administer those items.

Discontinue Rule: Stop administration when the child obtains a score of zero on five consecutive items.

Item	Materials	Score Criteria and Comments	Score
1. Thrusts Legs in Play	None	**Score:** Child randomly thrusts legs several times.	1 0
2. Thrusts Arms in Play	None	**Score:** Child randomly thrusts arms several times.	1 0
3. Controls Head While Upright Series: Lifts Head	Stopwatch	**Score:** Child intermittently lifts head free of your shoulder without support. Time head held upright:	1 0
4. Controls Head While Upright Series: 3 Seconds	Stopwatch	**Score:** Child holds head erect for at least 3 seconds without support. Time head held upright:	1 0
5. Turns Head to Sides	Object of interest	**Score:** Child turns head from one side to the other by raising his or her head off the supporting surface enough to clear the nose. Child must be able to turn to both sides.	1 0
6. Makes Crawling Movements	None	**Score:** Child makes any alternating crawling movements with his or her legs.	1 0
7. Controls Head in Dorsal Suspension	None	**Score:** Child maintains head in midline or lifts head slightly.	1 0
8. Controls Head in Ventral Suspension	None	**Score:** Child maintains head in midline or lifts head slightly.	1 0
9. Controls Head While Upright Series: 15 Seconds	Stopwatch 15 seconds	**Score:** Child holds head erect and steady for at least 15 seconds without support. Time head held upright:	1 0

Item	Materials	Score Criteria and Comments	Score
10. Holds Head in Midline	Object of interest Stopwatch 5 seconds	**Score:** Child holds head in midline for at least 5 seconds.	1 0
11. Holds Head Upright While Carried	None	**Score:** Child holds head erect and steady without support while being moved.	1 0
12. Controls Head While Prone Series: 45°	Object of interest	**Score:** Child maintains raised head at least 45° from exam surface for at least 2 seconds. If child holds head at 90°, record elapsed time:	1 0
13. Rights Head	None	**Score:** Child keeps head balanced and in same plane as body or child overcompensates by tilting head toward the vertical plane.	1 0
14. Rolls From Side to Back	None	**Score:** Child actively turns from both sides to his or her back.	1 0
15. Elevates Trunk While Prone Series: Elbows and Forearms	Object of interest	**Score:** Child elevates head and upper trunk by pushing up on elbows or forearms.	1 0
16. Sits With Support Series: Briefly	Stopwatch	**Score:** Child tenses muscles in an effort to maintain sitting position. Elapsed time:	1 0
17. Controls Head While Prone Series: 90°	Object of interest Stopwatch 5 seconds	**Score:** Child maintains head at least 90° from exam surface for at least 5 seconds.	1 0
18. Elevates Trunk While Prone Series: Shifts Weight	Object of interest	**Score:** Child shifts weight from one arm to the other.	1 0
19. Sits With Support Series: 30 Seconds	Stopwatch 30 seconds	**Score:** Child sits with slight support for at least 30 seconds.	1 0
20. Rolls From Back to Sides	Bell or rattle	**Score:** Child turns from back to both right and left sides.	1 0
21. Elevates Trunk While Prone Series: Extended Arms	Object of interest	**Score:** Child supports weight on both hands.	1 0

Item	Materials	Score Criteria and Comments	Score
22. Sits Without Support Series: 5 Seconds	Stopwatch 5 seconds	**Score:** Child sits alone without support for at least 5 seconds. Elapsed time:	1 0
23. Pulls Up to Sit	None	**Score:** Child holds onto your thumbs to pull up to sit.	1 0
24. Grasps Foot With Hands	Facial tissue	**Score:** Child brings one or both feet up to hands (above the hips) and grasps a foot.	1 0
25. Rolls From Back to Stomach	Bell or rattle	**Score:** Child rolls from back to stomach, rolling from either side.	1 0
26. Sits Without Support Series: 30 Seconds	Stopwatch 30 seconds	**Score:** Child sits alone without support for at least 30 seconds.	1 0
27. Sits Without Support and Holds Object	Object of interest Stopwatch 60 seconds	**Score:** Child sits alone for at least 60 seconds while manipulating an object.	1 0
28. Rotates Trunk While Seated	Bell or object of interest	**Score:** Child rotates his or her trunk and reaches for object.	1 0
29. Makes Stepping Movements	None	**Score:** Child makes at least two stepping movements that propel him or her forward, even if child does not fully support own weight.	1 0
30. Crawls Series: On Stomach	Object of interest	**Score:** Child uses both arms to move forward on stomach approximately three feet or more.	1 0
31. Crawls Series: Crawl Position	Object of interest	**Score:** Child moves from lying prone to being up on hands and knees.	1 0
32. Moves From Sitting to Hands and Knees	Object of interest	**Score:** Child moves from a seated position to hands and knees.	1 0
33. Supports Weight	None	**Score:** Child supports own weight for at least 2 seconds.	1 0

Item	Materials	Score Criteria and Comments	Score
34. Crawls Series: Crawl Movement	Object of interest	**Score:** Child makes forward progress of at least 5 feet by crawling on hands and knees.	1 0
35. Raises Self to Standing Position	Object of interest	**Score:** Child raises self to a standing position, using a chair or other convenient object for support.	1 0
36. Bounces While Standing	None	**Score:** Child bounces up and down at least twice by alternately bending and straightening the knees.	1 0
37. Walks Series: With Support	None	**Score:** Child walks by making coordinated, alternating stepping movements.	1 0
38. Walks Sideways With Support	Object of interest	**Score:** Child walks sideways while holding onto furniture for support and balance.	1 0
39. Sits Down With Control	None	**Score:** Child purposely lowers from a standing to a sitting position in a controlled manner.	1 0
40. Stands Alone	None	**Score:** Child stands alone for at least 3 seconds after you release his or her hands.	1 0
41. Stands Up Series: Alone	None	**Score:** Child comes to a standing position, rolling first to a prone or quadruped position, without using any support.	1 0
42. Walks Series: Alone	None	**Score:** Child takes at least three steps without support, even if gait is stiff-legged and wobbly.	1 0
43. Walks Series: Alone With Coordination	None	**Score:** Child takes at least five steps independently, displaying coordination and balance.	1 0
44. Throws Ball	Small ball	**Score:** Child purposely throws ball forward.	1 0

Behavior Observation Inventory

Respond to each statement by placing a check mark in the column that describes how often the behavior was observed during testing. For the Caregiver Ratings, read the description of each behavior to the caregiver and ask him or her to rate the degree to which each statement is typical of the child's everyday behavior.

Examiner Rating				Caregiver Rating		
Was observed never or rarely during testing	Was observed some of the time during testing	Was observed most of the time during testing		Is not at all typical; the child is like this never or rarely	Is somewhat typical; the child is like this some of the time	Is very typical; the child is like this most of the time
			Positive Affect Smiles and laughs			
			Enthusiasm Shows enthusiasm or excitement			
			Exploration Explores objects in the environment			
			Ease of Engagement Readily takes part in activities			
			Cooperativeness Cooperates with adult requests			
			Moderate Activity Works without becoming overly active or fidgety			
			Adaptability to Change Adapts easily to changes in stimulation or changes in routine			
			Alertness Quiet and attentive, not drowsy			
			Distractibility Unable to focus on task; distraction interferes with performance on items			
			Motor Tone Displays normal muscle tone: not overly stiff (high tone), floppy (low tone), or with tremors			
			Tactile Defensiveness Overly sensitive to touch or textures			
			Fear/Anxiety Approaches new tasks with apprehension; looks to caregiver for reassurance			
			Negative Affect Cries, frowns, whines, or complains			

Social-Emotional and Adaptive Behavior Questionnaire

Bayley Scales of Infant and Toddler Development™ THIRD EDITION

Child's name: ______
Sex: ☐M ☐F Age in months: ______
Completed by: ______
Relationship to child: ______
Examiner's name: ______
Does the child have any disabling conditions? ☐Yes ☐No
If yes, please describe: ______

An important part of your child's evaluation is to learn about how he or she interacts with you (e.g., whether he or she can communicate with you or recognize others' feelings and emotions). It is also important to learn about the daily skills your child has that help him or her to get along both at home and away from home. Because you know your child so well, you are one of the best people to provide this type of information. The Social-Emotional Scale (part 1 of the following Questionnaire) asks about your child's social-emotional skills. The Adaptive Behavior Scale (part 2) asks about the different kinds of skills your child has.

The items cover a wide age range, and your child is not expected to show all the skills described in the items. It is important that you accurately give information about what skills your child does and does not have. Please note that the two scales require slightly different responses, so read the directions for each scale carefully and mark your rating for each item.

Your child's age affects your completion of both scales. The Social-Emotional Scale has specific stop points, depending on the age of your child. The examiner should indicate where you should stop. Depending on your child's age, you may complete all of the Adaptive Behavior Scale or only certain sections. Although the age-specific sections are clearly marked, the examiner should discuss this with you prior to completion of the Questionnaire.

Calculate Age	Years	Months	Days
Date Tested			
Date of Birth			
Age			
Age in Months and Days	Years × 12 + months		
Adjustment for Prematurity	Adjust through 24 months		
Adjusted Age			

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ISBN 015402726-X

Social-Emotional Scale

Stanley I. Greenspan, M.D.

This scale is designed to measure how well your child has met certain social-emotional milestones for his or her age. Please note that this section has specific stop points, based on your child's age. For each question, circle the number in the column that best describes how often you observe the behavior in your child. Circle **only one** number for each question. Respond to all items until you reach the stop point for your child's age. If your child has not displayed the behavior, please circle 0 for **Can't tell**.

	Behavior Frequency					
	Can't tell	None of the time	Some of the time	Half of the time	Most of the time	All of the time
1. Takes a calm and enjoyable interest in most sounds.	0	1	2	3	4	5
2. You can easily get your child's attention without having to be very dramatic.	0	1	2	3	4	5
3. Takes a calm and enjoyable interest in most sights, including colorful or bright things.	0	1	2	3	4	5
4. You can easily get your child to look at things without them being very bright or colorful.	0	1	2	3	4	5
5. Calmly enjoys touching or being touched by different things.	0	1	2	3	4	5
6. You can easily get your child to respond to your touch without having to touch your child firmly to get his or her attention.	0	1	2	3	4	5
7. Likes to be swung around, danced with while in your arms, or quickly lifted up in the air.	0	1	2	3	4	5
8. You can easily get your child's attention by approaching him or her, or moving him or her around slowly.	0	1	2	3	4	5
For Sensory Processing Score calculations, total the scores for Items 1–8.						/40
9. You can help your child to calm down.	0	1	2	3	4	5
10. Looks at interesting sights, such as your face or a toy.	0	1	2	3	4	5
11. Looks at or turns toward interesting sounds.	0	1	2	3	4	5
Stop here if your child is 0–3 months old.			**Stage 1**			
12. Seems happy or pleased when he or she sees a favorite person (e.g., looks or smiles, makes sounds, or moves arms in a way that expresses joy or delight).	0	1	2	3	4	5
13. Responds to people talking or playing with him or her by making sounds or faces (e.g., happy sounds or a curious or annoyed look).	0	1	2	3	4	5
Stop here if your child is 4–5 months old.			**Stage 2**			
14. Reaches for or points at things, or makes distinct sounds to show you what he or she wants (e.g., reaches out to be picked up or points at a toy).	0	1	2	3	4	5
15. Exchanges two or more smiles, other looks, sounds, or actions (e.g., reaching, giving, or taking) with a favorite person.	0	1	2	3	4	5
Stop here if your child is 6–9 months old.			**Stage 3**			
16. Shows you that he or she understands your actions or gestures by making an appropriate gesture in return (e.g., makes a funny face back at you, looks at something you point to, stops doing something when you shake your head and use a firm voice to say "No!", or smiles and does more of something when you nod with a big smile and say "Yes!").	0	1	2	3	4	5
17. Uses many consecutive actions in a back-and-forth way to show you what he or she wants or to have fun with you (e.g., smiles, reaches out for a hug, and, when you hug, takes your hat, puts it on his or her head, and smiles proudly OR takes your hand, leads you to the refrigerator, tugs on the handle, and, after you open it, points to something he or she likes, such as food, a bottle of juice, or milk).	0	1	2	3	4	5
Stop here if your child is 10–14 months old.			**Stage 4a**			

	Behavior Frequency					
	Can't tell	None of the time	Some of the time	Half of the time	Most of the time	All of the time
18. Copies or imitates many of your sounds, words, or actions while playing with you (e.g., if you make funny faces and sounds, he or she copies them).	0	1	2	3	4	5
19. Searches for something he or she wants by looking or getting you to look for it.	0	1	2	3	4	5
20. Shows you what he or she wants or needs by using a few actions in a row (e.g., leads you by the hand to open a door and then touches or bangs on the door).	0	1	2	3	4	5
21. Uses words or tries to use words when people talk with or play with him or her.	0	1	2	3	4	5
Stop here if your child is 15–18 months old.			**Stage 4b**			
22. Copies or imitates familiar make-believe play (e.g., feeds or hugs a doll).	0	1	2	3	4	5
23. Tells you what he or she wants with one or a few words (e.g., "Juice," "Open," or "Kiss").	0	1	2	3	4	5
24. Shows you he or she understands your simple verbal wish (e.g., "Please show me your toy.").	0	1	2	3	4	5
Stop here if your child is 19–24 months old.			**Stage 5a**			
25. Plays make-believe (e.g., feeds a doll, plays house, or pretends to be a TV or movie character) with you or others.	0	1	2	3	4	5
26. Uses words or pictures to tell you what he or she is interested in (e.g., "See truck!").	0	1	2	3	4	5
27. Uses words with one or more peers.	0	1	2	3	4	5
28. Uses words or pictures to show what he or she likes or dislikes (e.g., "Want that." or "No want.").	0	1	2	3	4	5
Stop here if your child is 25–30 months old.			**Stage 5b**			
29. Plays make-believe with one or more peers.	0	1	2	3	4	5
30. Plays make-believe with you or others where the story makes sense (e.g., has the bears go visit grandmother and then have a big lunch).	0	1	2	3	4	5
31. Uses phrases or sentences with you to ask a question about something he or she wants to do (e.g., "Mommy go out?" "What you doing outside?" or "Play?").	0	1	2	3	4	5
32. Can explain why he or she wants something or wants to do something (e.g., "Why do you want the juice?" "Because I'm thirsty.").	0	1	2	3	4	5
33. Describes his or her feelings to explain why he or she is doing something or wants something (e.g., "Because I'm happy/sad/excited.").	0	1	2	3	4	5
34. Plays make-believe with peers as well as adults where the story makes sense and has many parts to it (e.g., the children go to school, do work, have lunch, and meet an elephant on the way home).	0	1	2	3	4	5
35. Has conversations with adults and peers that make sense, with four or more back-and-forth exchanges about a variety of topics (e.g., feelings, foods, bedtimes, friends, or school).	0	1	2	3	4	5
Stop here if your child is 31–42 months old.			**Stage 6**			

Social-Emotional Total Raw Score (Items 1–35) ______ /175

Adaptive Behavior Scale

Part 2 is designed to measure important behaviors a child displays at home, school, and in other settings. The behaviors included range from those suitable for infants to those suitable for young children. Some items may seem too difficult for infants while others may seem too easy for young children. Therefore, the child is likely to display some but not all behaviors included in this scale.

The Adaptive Behavior Scale includes 10 skill areas. Please read and answer ALL items in the appropriate skill areas, according to the following guidelines:

Age of child:	Complete:
Younger than 1 year old	Communication, Health and Safety, Leisure, Self-Care, Self-Direction, Social, and Motor skill areas only
1–3½ years old	All 10 skill areas

Rate the child according to how often he or she **correctly** performs a behavior, when the behavior needs to be displayed. The rating you choose should reflect the frequency with which the child performs the behavior **when it is needed**. The child should be able to perform the activity or behavior **without help** unless otherwise indicated in the item. Record your response for each item by circling one of the following:

0 Is Not Able
1 Never or **Almost Never When Needed**
2 Sometimes When Needed
3 Always or **Almost Always When Needed**

Then evaluate whether you have observed the behavior or if you are guessing about the frequency of its occurrence. If your rating is based on a guess, put a check (✓) in the box marked **Check If You Guessed**. If your answer is based on observation or direct knowledge, leave this column blank.

The following example shows how to complete the Adaptive Behavior Scale:

	Behavior Frequency				
	Is not able	Never when needed	Sometimes when needed	Always when needed	Check if you guessed
3. Rolls from stomach to side.	0	1	2	3	☐
4. Shakes rattle or other toys.	0	1	2	3	☑
5. Reaches for objects such as a bottle or toy.	0	1	2	3	☐

In the example above, the child being rated **Always** (or Almost Always) rolls from stomach to side when needed; **Sometimes** shakes a rattle or other toys; and **Is Not Able** to reach for objects such as a bottle or toy. The ratings of Items 3 and 5 are based on observation or direct knowledge; therefore the **Check If You Guessed** column is left blank. The rater guessed on Item 4, so the **Check If You Guessed** column is marked.

The following table is provided to further assist you.

Rating	The child:
0 Is Not Able	• cannot perform the behavior; • is too young to have tried the behavior; or • has a physical condition that prevents the behavior.
1 Never or **Almost Never When Needed**	**has the ability to perform the behavior, but** • never or almost never does it when needed; or • never or almost never does it on his or her own without being reminded.
2 Sometimes When Needed	**has the ability to perform the behavior, and** • only does it sometimes when needed; • sometimes does it without help, but sometimes needs help; or • sometimes does it on his or her own, but sometimes needs to be reminded.
3 Always or **Almost Always When Needed**	**has the ability to perform the behavior, and** • displays the behavior most or all of the time without being reminded; or • displayed the behavior at a younger age, but has now outgrown it.

Column	Check this column if:
Check If You Guessed	• your rating was an estimate. • you have never seen the child in a situation in which the behavior is needed. • the child has not had the opportunity to perform the behavior.

If you do not understand an item or feel it would be helpful to discuss an item with the assessment professional, mark the item and make a brief note of your concerns on page 15 of this Questionnaire.

Communication	Is not able	Never when needed	Sometimes when needed	Always when needed	Check if you guessed
1. Looks at others' faces when they are talking.	0	1	2	3	☐
2. Laughs when a parent or other person laughs.	0	1	2	3	☐
3. Raises and lowers voice to express different feelings or needs.	0	1	2	3	☐
4. Cries or fusses when upset.	0	1	2	3	☐
5. Raises voice to get attention.	0	1	2	3	☐
6. Says the names of other people (e.g., Mama, Daddy, or friends' names).	0	1	2	3	☐
7. Shakes head or says "Yes" or "No" in response to a simple question (e.g., "Do you want something to drink?").	0	1	2	3	☐
8. Points to common items in a room when asked (e.g., "Show me the TV.").	0	1	2	3	☐
9. Listens closely for at least one minute when people talk.	0	1	2	3	☐
10. Repeats words others say (e.g., says "baby" when an adult says "baby").	0	1	2	3	☐
11. Says the name of an object clearly enough so that others recognize it (e.g., ball, dog, or cup).	0	1	2	3	☐
12. Follows simple commands (e.g., "No." or "Come here.").	0	1	2	3	☐
13. Follows simple directions that include *over* or *under* (e.g., "Put your hands over your head.").	0	1	2	3	☐
14. Sings all or part of the words to songs.	0	1	2	3	☐
15. Makes plurals of words by adding an *-s* (e.g., shoes, socks, or dogs).	0	1	2	3	☐
16. Names 20 or more familiar objects.	0	1	2	3	☐
17. Uses sentences with a noun and a verb.	0	1	2	3	☐
18. Speaks in sentences of six or more words.	0	1	2	3	☐

continued

Communication *continued*	Is not able	Never when needed	Sometimes when needed	Always when needed	Check if you guessed
19. Tells parent, friends, or others about his or her favorite activities.	0	1	2	3	☐
20. Asks questions (e.g., "Will you play with me?").	0	1	2	3	☐
21. Uses past tense to talk about prior events (e.g., "I stayed inside.").	0	1	2	3	☐
22. Discusses a topic for more than 3 minutes.	0	1	2	3	☐
23. Ends conversations appropriately.	0	1	2	3	☐
24. Refrains from interrupting others when they are talking.	0	1	2	3	☐
25. States his or her own telephone number.	0	1	2	3	☐
Total Raw Score (Communication Items 1–25)				/75	Total Guessed

Community Use

Do not complete the Community Use skill area if the child being rated is younger than one year.

1. Recognizes own home in his or her immediate neighborhood.	0	1	2	3	☐
2. Walks on sidewalk rather than street.	0	1	2	3	☐
3. Informs parents when someone comes to the door.	0	1	2	3	☐
4. Shows respect for public property (e.g., throws trash in cans, does not damage property).	0	1	2	3	☐
5. Knocks on a door or rings the doorbell before entering another person's home.	0	1	2	3	☐
6. Refrains from talking loudly in a public place (e.g., in a theater, movie, or church).	0	1	2	3	☐
7. Remains seated during a religious service or a movie.	0	1	2	3	☐
8. Refrains from touching items in a store.	0	1	2	3	☐
9. Asks to go to a park or other favorite community place.	0	1	2	3	☐
10. Asks to eat in a favorite restaurant.	0	1	2	3	☐
11. Says what items are purchased at various stores (e.g., food at grocery stores).	0	1	2	3	☐
12. Recognizes and names buildings (e.g., hospital, gas station, or fire department).	0	1	2	3	☐
13. Recognizes the need to pay for an item before leaving a store.	0	1	2	3	☐
14. Identifies neighborhood locations where his or her family obtains needed items (e.g., where to buy food).	0	1	2	3	☐
15. Describes the duties of workers (e.g., says that firefighters put out fires and doctors help the sick).	0	1	2	3	☐
16. Looks both ways before crossing a street or parking lot.	0	1	2	3	☐
17. Asks to go to the library.	0	1	2	3	☐
18. Finds the restroom in public places.	0	1	2	3	☐
19. Orders his or her own meals when eating out.	0	1	2	3	☐
20. Makes a small purchase at a food store.	0	1	2	3	☐
21. Walks alone to friends' houses in the neighborhood.	0	1	2	3	☐
22. Carries enough money to make small purchases (e.g., a soft drink).	0	1	2	3	☐
Total Raw Score (Community Use Items 1–22)				/66	Total Guessed

Functional Pre-Academics

Do not complete the Functional Pre-Academics skill area if the child being rated is younger than one year.

	Is not able	Never when needed	Sometimes when needed	Always when needed	Check if you guessed
1. Points to pictures in books when asked (e.g., points to a horse or cow).	0	1	2	3	☐
2. Holds crayon or pencil with point down when using paper.	0	1	2	3	☐
3. States his or her age in years when asked.	0	1	2	3	☐
4. Counts three or more objects.	0	1	2	3	☐
5. Attempts to imitate simple drawings (e.g., copying a line or circle).	0	1	2	3	☐
6. Sings the alphabet song.	0	1	2	3	☐
7. Names six or more colors including red, blue, and yellow.	0	1	2	3	☐
8. Recites nursery rhymes from memory.	0	1	2	3	☐
9. Identifies at least two numbers from a group of numbers.	0	1	2	3	☐
10. Names four or more shapes (e.g., circle, square, rectangle, and triangle).	0	1	2	3	☐
11. Reads own name when printed.	0	1	2	3	☐
12. Counts 10 or more objects without using fingers.	0	1	2	3	☐
13. Draws a recognizable face including two eyes, a nose, mouth, and hair.	0	1	2	3	☐
14. Names at least two letters when shown own name.	0	1	2	3	☐
15. Names most letters when shown the alphabet.	0	1	2	3	☐
16. Counts from 1 to 20.	0	1	2	3	☐
17. Prints at least two letters in own name.	0	1	2	3	☐
18. Reads and obeys common signs (e.g., *Do Not Enter, Exit,* or *Stop*).	0	1	2	3	☐
19. States the days of the week in order.	0	1	2	3	☐
20. Writes numbers 1 to 10.	0	1	2	3	☐
21. Tells what day comes before another (e.g., "Wednesday comes before Thursday.").	0	1	2	3	☐
22. Writes his or her first and last names.	0	1	2	3	☐
23. States time and day of favorite television shows.	0	1	2	3	☐
Total Raw Score (Functional Pre-Academics Items 1–23)				/69	Total Guessed

Home Living

Do not complete the Home Living skill area if the child being rated is younger than one year.

1. Removes cookies, chips, or other food from a box or bag.	0	1	2	3	☐
2. Turns television on and off.	0	1	2	3	☐
3. Shows concern when he or she spills something (e.g., says "Oh no!" or tells an adult).	0	1	2	3	☐
4. Points to the place where his or her clothes are stored.	0	1	2	3	☐
5. Uses wall switch to turn lights on and off, even if a chair or stool is needed.	0	1	2	3	☐
6. Assists other people with putting away toys, games, and other items.	0	1	2	3	☐
7. Picks up and throws away trash or paper at home.	0	1	2	3	☐
8. Does simple errand when asked (e.g., runs to get a towel for a spill).	0	1	2	3	☐
9. Attempts to wipe up spills, even if an adult must help.	0	1	2	3	☐
10. Refrains from kicking or hitting furniture.	0	1	2	3	☐
11. Gets own snacks from cabinet or pantry.	0	1	2	3	☐
12. Offers to help a parent or other adult with tasks.	0	1	2	3	☐

continued

Home Living *continued*

Do not complete the Home Living skill area if the child being rated is younger than one year.

Behavior Frequency	Is not able	Never when needed	Sometimes when needed	Always when needed	Check if you guessed
13. Refrains from throwing food or paper on the floor.	0	1	2	3	☐
14. Assists adults with preparing simple snacks or meals (e.g., hands slices of bread to adult for making sandwiches).	0	1	2	3	☐
15. Places dirty clothes in the proper place (e.g., a hamper or clothesbasket).	0	1	2	3	☐
16. Wipes up spills at home.	0	1	2	3	☐
17. Puts own dirty glass or plate in sink or dishwasher.	0	1	2	3	☐
18. Takes own clothes from drawers or closet when getting dressed.	0	1	2	3	☐
19. Keeps dirty shoes and feet off furniture.	0	1	2	3	☐
20. Puts things in their proper places when finished using them.	0	1	2	3	☐
21. Keeps toys, games, and other belongings neat and clean.	0	1	2	3	☐
22. Wipes wet or dirty shoes before entering a house or a building.	0	1	2	3	☐
23. Disposes of own leftover food.	0	1	2	3	☐
24. Makes his or her own bed.	0	1	2	3	☐
25. Folds clean clothes.	0	1	2	3	☐
Total Raw Score (Home Living Items 1–25)				/75	Total Guessed

Health and Safety

1. Cries or whimpers when he or she does not feel well or is injured.	0	1	2	3	☐
2. Swallows liquid medicines if needed for illness.	0	1	2	3	☐
3. Avoids bumping into walls or objects when crawling or walking.	0	1	2	3	☐
4. Shows, points to, or tells another person about a cut, bruise, or other minor injury.	0	1	2	3	☐
5. Follows an adult's directions to "Stop" when in danger (e.g., near a hot stove).	0	1	2	3	☐
6. Points to the body part that hurts when sick or injured.	0	1	2	3	☐
7. Avoids getting too near a fire or hot stove.	0	1	2	3	☐
8. Allows temperature to be taken without fussing.	0	1	2	3	☐
9. Remains fairly still when an adult treats a cut or scrape.	0	1	2	3	☐
10. Tests hot foods before eating them.	0	1	2	3	☐
11. Avoids touching or playing with dangerous items (e.g., insect spray or sharp knives).	0	1	2	3	☐
12. Tells an adult if he or she has a stomach ache or other illness.	0	1	2	3	☐
13. Refrains from putting toys in mouth.	0	1	2	3	☐
14. Avoids crawling or climbing on high or dangerous places.	0	1	2	3	☐
15. Stays within sight of parents or other familiar adults in a public place without wandering off.	0	1	2	3	☐
16. Puts on a coat or sweater when cold.	0	1	2	3	☐
17. Carries breakable objects safely and carefully.	0	1	2	3	☐
18. Asks an adult before going near something that could be dangerous (e.g., animals or playground equipment).	0	1	2	3	☐
19. Buckles his or her seatbelt in a car.	0	1	2	3	☐
20. Carries scissors safely.	0	1	2	3	☐
21. Follows safety rules for fire or weather alarms at home.	0	1	2	3	☐

Health and Safety *continued*

Behavior Frequency	Is not able	Never when needed	Sometimes when needed	Always when needed	Check if you guessed
22. Carries hot containers safely and carefully.	0	1	2	3	☐
23. Uses electrical outlets or sockets safely.	0	1	2	3	☐
24. Cares for his or her minor injuries (e.g., paper cuts, knee scrapes, or nosebleeds).	0	1	2	3	☐
Total Raw Score (Health and Safety Items 1–24)				/72	Total Guessed

Leisure

1. Plays with a single toy or game for at least one minute.	0	1	2	3	☐
2. Plays alone with toys, games, or other fun activities.	0	1	2	3	☐
3. Looks at pictures in books or magazines with an adult.	0	1	2	3	☐
4. Watches for a few minutes as people play with toys or games.	0	1	2	3	☐
5. Plays simple games like "peek-a-boo" or rolls a ball to others.	0	1	2	3	☐
6. Chooses a game or toy during playtime.	0	1	2	3	☐
7. Plays with a single toy or game for more than five minutes.	0	1	2	3	☐
8. Plays on playground equipment with an adult.	0	1	2	3	☐
9. Plays with toys, games, or other fun items with other people.	0	1	2	3	☐
10. Plays with other children when asked.	0	1	2	3	☐
11. Plays on playground equipment.	0	1	2	3	☐
12. Asks to be read to from a favorite book.	0	1	2	3	☐
13. Attends fun activities at another's home.	0	1	2	3	☐
14. Plays simple games with playmates without adult supervision.	0	1	2	3	☐
15. Invites others to join him or her in playing games and other fun activities.	0	1	2	3	☐
16. Participates in a specific fun activity on a routine basis (e.g., listening to a certain type of music or playing a favorite computer game).	0	1	2	3	☐
17. Waits for his or her own turn in games and other fun activities.	0	1	2	3	☐
18. Saves things of interest (e.g., rocks, feathers, or pictures).	0	1	2	3	☐
19. Invites others home for a fun activity.	0	1	2	3	☐
20. Plays simple board games.	0	1	2	3	☐
21. Follows the rules in games.	0	1	2	3	☐
22. Participates in an organized program for a sport or hobby (e.g., takes a music class or practices basketball).	0	1	2	3	☐
Total Raw Score (Leisure Items 1–22)				/66	Total Guessed

Self-Care

1. Swallows liquids with no difficulty.	0	1	2	3	☐
2. Nurses, drinks, or eats willingly, with little encouragement.	0	1	2	3	☐
3. Swallows soft, strained, or mashed food (e.g., baby food or applesauce).	0	1	2	3	☐
4. Sleeps through most of the night, waking no more than one or two times.	0	1	2	3	☐
5. Opens mouth when offered food on a spoon.	0	1	2	3	☐
6. Feeds himself or herself crackers, cookies, dry cereal, or other finger foods.	0	1	2	3	☐
7. Drinks from a cup or glass, even if another person must hold it.	0	1	2	3	☐

continued

Self-Care *continued*

Behavior Frequency	Is not able	Never when needed	Sometimes when needed	Always when needed	Check if you guessed
8. Holds and drinks from a sipping cup.	0	1	2	3	☐
9. Lifts arms as needed when another person is dressing or undressing him or her.	0	1	2	3	☐
10. Points to or asks for food when hungry.	0	1	2	3	☐
11. Takes shoes off.	0	1	2	3	☐
12. Sleeps through the entire night without waking.	0	1	2	3	☐
13. Washes hands with soap.	0	1	2	3	☐
14. Sits on the toilet or potty seat without being held.	0	1	2	3	☐
15. Wipes own face when given a cloth by an adult.	0	1	2	3	☐
16. Goes to bed with few or no complaints.	0	1	2	3	☐
17. Tells parent or other adult when he or she needs to use the bathroom.	0	1	2	3	☐
18. Brushes own teeth with little fussing when told by an adult.	0	1	2	3	☐
19. Uses bathroom without help.	0	1	2	3	☐
20. Dresses himself or herself.	0	1	2	3	☐
21. Buttons his or her own clothing.	0	1	2	3	☐
22. Takes a bath or shower without help.	0	1	2	3	☐
23. Washes his or her own hair.	0	1	2	3	☐
24. Cuts meats or other foods into bite-size pieces.	0	1	2	3	☐
Total Raw Score (Self-Care Items 1–24)				/72	Total Guessed

Self-Direction

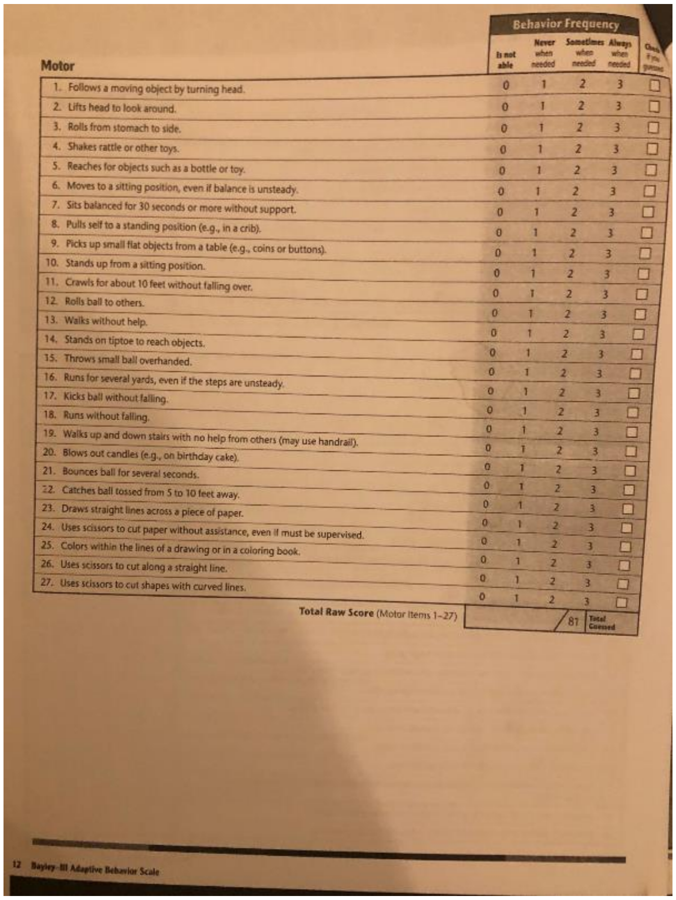
1. Shows interest in a toy or other object by looking at it for a few seconds.	0	1	2	3	☐
2. Stops fussing or crying when picked up or spoken to.	0	1	2	3	☐
3. Entertains self in crib or bed for at least one minute after waking.	0	1	2	3	☐
4. Sits quietly for at least one minute without demanding attention.	0	1	2	3	☐
5. Finds something to do for at least five minutes without demanding attention.	0	1	2	3	☐
6. Shows interest in a toy or other object by pointing to it.	0	1	2	3	☐
7. Moves a few feet away from a parent in a new situation as long as the parent is in sight (e.g., when visiting in an unfamiliar house).	0	1	2	3	☐
8. Chooses the food or snack he or she wishes to eat when given a choice.	0	1	2	3	☐
9. Explores an unfamiliar room or other new situation, even if parent must encourage it (e.g., a waiting room).	0	1	2	3	☐
10. Obeys an adult's request to "Quiet down" or "Behave."	0	1	2	3	☐
11. Tries to do most things without an adult's help (e.g., dressing or feeding self).	0	1	2	3	☐
12. Follows simple household rules such as *No running in the house.*	0	1	2	3	☐
13. Resists pushing or hitting another child when angry or upset.	0	1	2	3	☐
14. Starts an activity almost immediately when told to do so (e.g., taking a bath).	0	1	2	3	☐
15. Keeps working on hard tasks without becoming discouraged or quitting.	0	1	2	3	☐
16. Asks permission from adult when needed (e.g., "May I play outside?").	0	1	2	3	☐
17. Works independently and asks for help only when necessary.	0	1	2	3	☐

Self-Direction *continued*

Behavior Frequency	Is not able	Never when needed	Sometimes when needed	Always when needed	Check if you guessed
18. Controls temper when a parent or other adult takes a toy or object away.	0	1	2	3	☐
19. Works on one home or school activity for at least 15 minutes.	0	1	2	3	☐
20. Stops a fun activity, without complaints, when told that time is up.	0	1	2	3	☐
21. Controls temper when disagreeing with friends.	0	1	2	3	☐
22. Follows a routine without being reminded (e.g., brushing teeth before bedtime or regularly feeding a pet).	0	1	2	3	☐
23. Asks permission before playing with another child's toy or game.	0	1	2	3	☐
24. Chooses own clothes almost every day.	0	1	2	3	☐
25. Discusses ways to solve conflicts with others (e.g., "You can have this now if I can have it later.").	0	1	2	3	☐
Total Raw Score (Self-Direction Items 1–25)				/75	Total Guessed

Social

1. Smiles when he or she sees parent.	0	1	2	3	☐
2. Squeals or laughs when happy or delighted.	0	1	2	3	☐
3. Relaxes body when held (e.g., snuggles).	0	1	2	3	☐
4. Lifts arms to express a desire to be picked up.	0	1	2	3	☐
5. Shows a sense of humor (e.g., laughs when someone acts silly).	0	1	2	3	☐
6. Displays a special closeness or relationship to parent (e.g., acts happy when parent returns).	0	1	2	3	☐
7. Responds differently to familiar and unfamiliar persons (e.g., is less warm to an unfamiliar person).	0	1	2	3	☐
8. Hugs and kisses parents or others.	0	1	2	3	☐
9. Runs to greet special family members and friends.	0	1	2	3	☐
10. Imitates actions of adults (e.g., pretends to clean house or drive a car).	0	1	2	3	☐
11. Shares toys willingly with others.	0	1	2	3	☐
12. Greets other children (e.g., says "Hi").	0	1	2	3	☐
13. Says "Thank you" when given a gift.	0	1	2	3	☐
14. Shows sympathy for others when they are sad or upset.	0	1	2	3	☐
15. Seeks friendship with others in his or her age group.	0	1	2	3	☐
16. Responds appropriately when introduced to others (e.g., says "Hello").	0	1	2	3	☐
17. Moves out of another person's way without being asked.	0	1	2	3	☐
18. Offers assistance to others (e.g., offers to carry packages or put away food).	0	1	2	3	☐
19. Says when he or she feels happy, sad, scared, or angry.	0	1	2	3	☐
20. States when others seem happy, sad, scared, or angry.	0	1	2	3	☐
21. Apologizes if he or she hurts the feelings of others.	0	1	2	3	☐
22. Places reasonable demands on friends (e.g., does not become upset when a friend plays with another friend).	0	1	2	3	☐
23. Refrains from saying something that might embarrass or hurt others.	0	1	2	3	☐
24. Personally makes or buys gifts for family members on major holidays.	0	1	2	3	☐
Total Raw Score (Social Items 1–24)				/72	Total Guessed

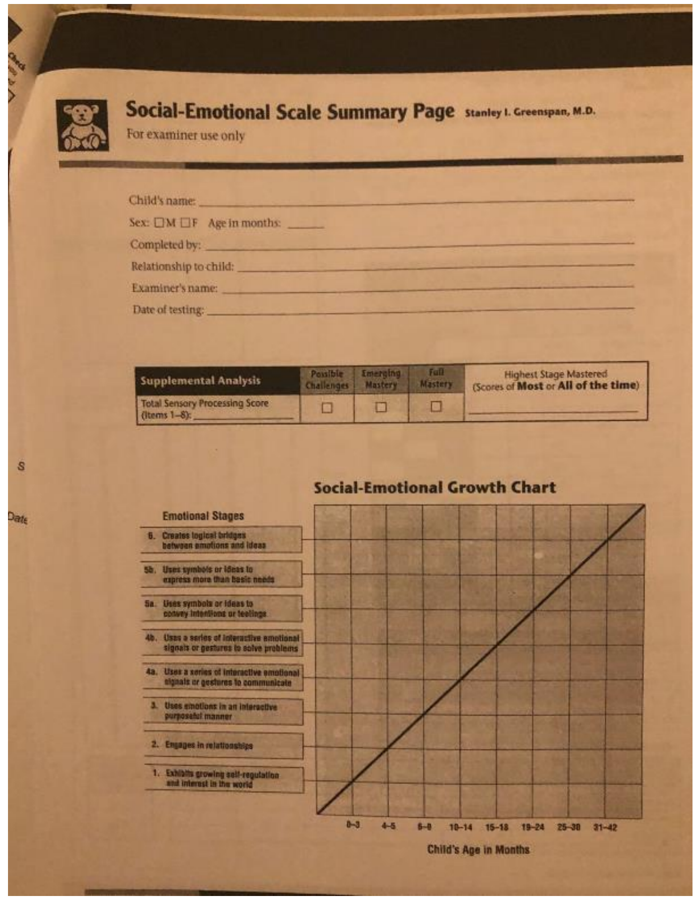


Motor

Motor	Behavior Frequency: Is not able	Never when needed	Sometimes when needed	Always when needed	Check if you guessed
1. Follows a moving object by turning head.	0	1	2	3	☐
2. Lifts head to look around.	0	1	2	3	☐
3. Rolls from stomach to side.	0	1	2	3	☐
4. Shakes rattle or other toys.	0	1	2	3	☐
5. Reaches for objects such as a bottle or toy.	0	1	2	3	☐
6. Moves to a sitting position, even if balance is unsteady.	0	1	2	3	☐
7. Sits balanced for 30 seconds or more without support.	0	1	2	3	☐
8. Pulls self to a standing position (e.g., in a crib).	0	1	2	3	☐
9. Picks up small flat objects from a table (e.g., coins or buttons).	0	1	2	3	☐
10. Stands up from a sitting position.	0	1	2	3	☐
11. Crawls for about 10 feet without falling over.	0	1	2	3	☐
12. Rolls ball to others.	0	1	2	3	☐
13. Walks without help.	0	1	2	3	☐
14. Stands on tiptoe to reach objects.	0	1	2	3	☐
15. Throws small ball overhanded.	0	1	2	3	☐
16. Runs for several yards, even if the steps are unsteady.	0	1	2	3	☐
17. Kicks ball without falling.	0	1	2	3	☐
18. Runs without falling.	0	1	2	3	☐
19. Walks up and down stairs with no help from others (may use handrail).	0	1	2	3	☐
20. Blows out candles (e.g., on birthday cake).	0	1	2	3	☐
21. Bounces ball for several seconds.	0	1	2	3	☐
22. Catches ball tossed from 5 to 10 feet away.	0	1	2	3	☐
23. Draws straight lines across a piece of paper.	0	1	2	3	☐
24. Uses scissors to cut paper without assistance, even if must be supervised.	0	1	2	3	☐
25. Colors within the lines of a drawing or in a coloring book.	0	1	2	3	☐
26. Uses scissors to cut along a straight line.	0	1	2	3	☐
27. Uses scissors to cut shapes with curved lines.	0	1	2	3	☐

Total Raw Score (Motor Items 1–27) ____ /81 Total Guessed

12 Bayley-III Adaptive Behavior Scale



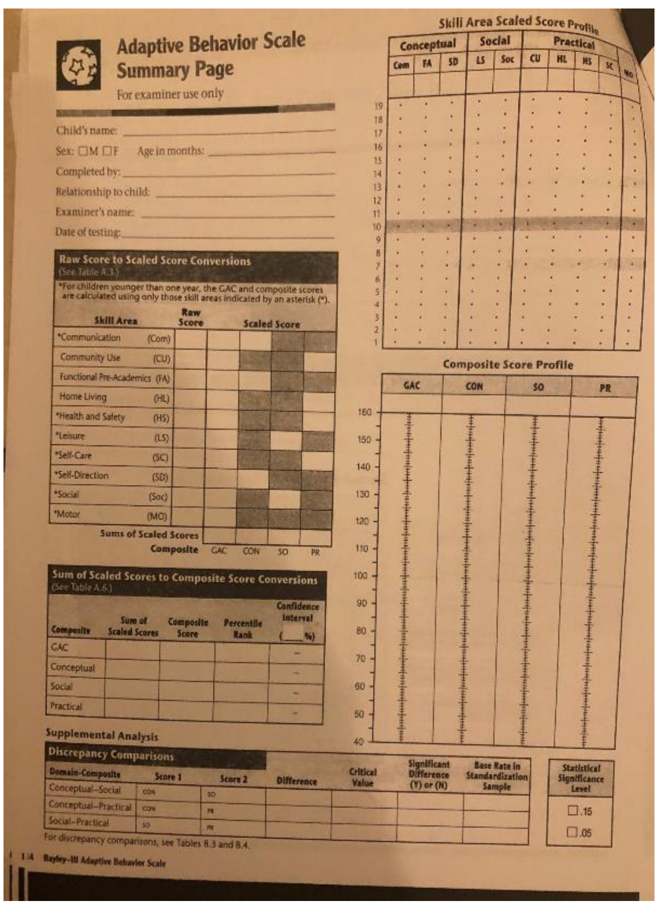
Social-Emotional Scale Summary Page Stanley I. Greenspan, M.D.

For examiner use only

Child's name: ____
Sex: ☐M ☐F Age in months: ____
Completed by: ____
Relationship to child: ____
Examiner's name: ____
Date of testing: ____

Supplemental Analysis	Possible Challenges	Emerging Mastery	Full Mastery	Highest Stage Mastered (Scores of **Most** or **All of the time**)
Total Sensory Processing Score (Items 1–8):	☐	☐	☐	

Social-Emotional Growth Chart



Adaptive Behavior Scale Summary Page

For examiner use only

Child's name: ____
Sex: ☐M ☐F Age in months: ____
Completed by: ____
Relationship to child: ____
Examiner's name: ____
Date of testing: ____

Raw Score to Scaled Score Conversions (See Table A.3.)

*For children younger than one year, the GAC and composite scores are calculated using only those skill areas indicated by an asterisk (*).

Skill Area		Raw Score	Scaled Score
*Communication	(Com)		
Community Use	(CU)		
Functional Pre-Academics	(FA)		
Home Living	(HL)		
*Health and Safety	(HS)		
*Leisure	(LS)		
*Self-Care	(SC)		
*Self-Direction	(SD)		
*Social	(Soc)		
*Motor	(MO)		
Sums of Scaled Scores			
Composite			GAC CON SO PR

Sum of Scaled Scores to Composite Score Conversions (See Table A.6.)

Composite	Sum of Scaled Scores	Composite Score	Percentile Rank	Confidence Interval (%)
GAC				–
Conceptual				–
Social				–
Practical				–

Supplemental Analysis

Discrepancy Comparisons

Domain-Composite	Score 1	Score 2	Difference	Critical Value	Significant Difference (Y) or (N)	Base Rate in Standardization Sample	Statistical Significance Level
Conceptual–Social	CON	SO					☐.15
Conceptual–Practical	CON	PR					☐.05
Social–Practical	SO	PR					

For discrepancy comparisons, see Tables B.3 and B.4.

Skill Area Scaled Score Profile

Composite Score Profile

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APPENDIX F Ethical Clearance Certificate

R14/49 Miss Nicole Paul

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M150904

NAME: (Principal Investigator)	Miss Nicole Paul
DEPARTMENT:	Occupational Therapy Edenvale General Hospital
PROJECT TITLE:	The Association between Demographic/Environmental factors and Development and Sensory Modulation in Preterm Infants
DATE CONSIDERED:	02/10/2015
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Lizelle Jacobs
APPROVED BY:	Professor P Cleaton-Jones,Chairperson, HREC (Medical)
DATE OF APPROVAL:	17/08/2016

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary in Room 10004, 10th floor, Senate House/2nd Floor, Phillip Tobias Building, Parktown, University of the Witwatersrand. I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in September and will therefore be due in the month of September each year.

Principal Investigator Signature ____________ Date ____________

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

APPENDIX G Information Sheet – Parents/Caregivers

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

Dear Parent/Caregiver,

My name is Nicole Paul and I am a registered MSc Occupational Therapy student at the University of the Witwatersrand.

I am undertaking a study entitled: *"ENVIRONMENTAL FACTORS, SENSORY MODULATION AND DEVELOPMENT OF PRETERM INFANTS IN THE NEONATAL HIGH CARE UNIT".*

This study is to investigate children who are not born at full term and stay in the hospital after birth, have any problems developing. If these children have any problems with their development, it is good to identify the problems at an early age as Occupational Therapists are able to treat these problems that could be identified.

You will be asked to fill out one questionnaire at your 4 week follow-up appointment and again one questionnaire about your child while the Occupational Therapist assess your child at 4-6 months old. This assessment will be roughly 50 to 90 minutes long and will be able to tell us if your child is having any problems with their development.

If your child is not growing and developing as expected, feedback will be given to you about your child and a plan to help your child will be discussed with you following your 10-12 month appointment for your child.

Filling out the questionnaires and assessing your child will help to gain knowledge around children who are born early and their development.

This study has received clearance from the Human Research Ethics Committee (Medical) and been approved by the Faculty of Health Sciences Post Graduate Committee.

THERAPEUTIC Sciences

I would like to invite you to take part in my study. I will not need any names or identifying data on the questionnaire, this will ensure your child's confidentiality. All data will be available to only me and my supervisor. The data will be stored in a safe location for six years according to HPCSA regulations.

Participation in the study is voluntary and deciding to withdraw at any time will have no consequences.

Please feel free to contact me or my supervisor, Mrs Lizelle Jacobs with any queries on (011) 717 3701. If you have any ethical concerns please feel free to contact the HREC administrator and chair from the Wits Research Office on (011) 7171234.

Many Thanks

Nicole Paul

Occupational Therapist

0834301627

INFORMED CONSENT FORM

I, parent/ caregiver of ______________________________________, give my consent to participate in the study *“ENVIRONMENTAL FACTORS, SENSORY MODULATION AND DEVELOPMENT OF PRETERM INFANTS IN THE NEONATAL HIGH CARE UNIT”.”.*

I understand that confidentiality is ensured.

Signature ___________________________________

Date _______________________________________

APPENDIX H Permission Letter – Hospital CEO

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

Dear Dr Kerns,

My name is Nicole Paul and I am a registered MSc Occupational Therapy student at the University of the Witwatersrand.

I would like to request your permission to conduct the following study:

"ENVIRONMENTAL FACTORS, SENSORY MODULATION AND DEVELOPMENT OF PRETERM INFANTS IN THE NEONATAL HIGH CARE UNIT".

This study will investigate if there is an association between demographic and environmental factors influence on development and sensory modulation in preterm infants at age 4-6 months (corrected age) post discharge from the NHCU.

This is related to occupational therapy, as the research found in this study will be pertinent to occupational therapists who work with premature infants, as it will allow them to be able to identify premature infants in need of early intervention.

This study has received clearance from the Human Research Ethics Committee (Medical) and been approved by the Faculty of Health Sciences Post Graduate Committee.

I will not need any names or identifying data on the questionnaire, this will ensure the participants confidentiality. All data will be available to only the researcher and the supervisor. The data will be stored in a safe location for six years according to HPCSA regulations.

Participation in the study is voluntary and deciding to withdraw at any time will have no consequences. If developmental delay or sensory modulation deficits are identified, the

THERAPEUTIC Sciences

participant will be contacted and referred to the rehabilitation professionals for intervention.

Please feel free to contact myself or my supervisor Mrs Lizelle Jacobs with any queries on (011) 717 3701. If you have any ethical concerns please feel free to contact the HREC administrator and chair from the Wits Research office on (011) 7171234

Many Thanks

Nicole Paul

Occupational Therapy

0834301627

INFORMED CONSENT FORM

I, CEO of Edenvale Hospital, give my consent to use Edenvale General Hospital in the study *"The association between demographic/environmental factors and development and sensory modulation in preterm infants"*.

I understand that confidentiality is ensured.

Signature ____________________

Date 07.05.16

Dr. N.P. Kernes MB.Bch(Wits). B.Proc.(Wits).
Chief Executive Officer

APPENDIX I Permission Letter – Head of Department of the Neonatal High Care Unit

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

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

Dear Dr Gwavu,

My name is Nicole Paul and I am a registered MSc Occupational Therapy student at the University of the Witwatersrand.

I would like to request your permission to conduct the following study:

"ENVIRONMENTAL FACTORS, SENSORY MODULATION AND DEVELOPMENT OF PRETERM INFANTS IN THE NEONATAL HIGH CARE UNIT".

This study will investigate if there is an association between demographic and environmental factors influence on development and sensory modulation in preterm infants at age 4-6 months (corrected age) post discharge from the NHCU.

This is related to occupational therapy, as the research found in this study will be pertinent to occupational therapists who work with premature infants, as it will allow them to be able to identify premature infants in need of early intervention.

This study has received clearance from the Human Research Ethics Committee (Medical) and been approved by the Faculty of Health Sciences Post Graduate Committee.

I will not need any names or identifying data on the questionnaire, this will ensure the participants confidentiality. All data will be available to only the researcher and the supervisor. The data will be stored in a safe location for six years according to HPCSA regulations.

THERAPEUTIC Sciences

Participation in the study is voluntary and deciding to withdraw at any time will have no consequences. If developmental delay or sensory modulation deficits are identified, the participant will be contacted and referred to the rehabilitation professionals for intervention.

Please feel free to contact myself or my supervisor Mrs Lizelle Jacobs with any queries on (011) 717 3701. If you have any ethical concerns please feel free to contact the HREC administrator and chair from the Wits Research office on (011) 7171234.

Many Thanks

Nicole Paul

Occupational Therapy

0834301627

PERMISSION TO CONDUCT RESEARCH

PERMISSION TO CONDUCT RESEARCH

I, DR N. GWAVU, Head of Department of the NHCU, give my consent to use the NHCU of Edenvale General Hospital in the study *"The association between demographic/environmental factors and development and sensory modulation in preterm infants".*

I understand that confidentiality is ensured.

Signature ______________________

Date 08/06/2020

APPENDIX J Permission Letter – Head of Department of Occupational Therapy

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

Dear Ms Mugeri,

My name is Nicole Paul and I am a registered MSc Occupational Therapy student at the University of the Witwatersrand.

I would like to request your permission to conduct the following study:

"ENVIRONMENTAL FACTORS, SENSORY MODULATION AND DEVELOPMENT OF PRETERM INFANTS IN THE NEONATAL HIGH CARE UNIT".

This study will investigate if there is an association between demographic and environmental factors influence on development and sensory modulation in preterm infants at age 4-6 months (corrected age) post discharge from the NHCU.

This is related to occupational therapy, as the research found in this study will be pertinent to occupational therapists who work with premature infants, as it will allow them to be able to identify premature infants in need of early intervention.

This study has received clearance from the Human Research Ethics Committee (Medical) and been approved by the Faculty of Health Sciences Post Graduate Committee.

I will not need any names or identifying data on the questionnaire, this will ensure the participants confidentiality. All data will be available to only the researcher and the supervisor. The data will be stored in a safe location for six years according to HPCSA regulations.

Participation in the study is voluntary and deciding to withdraw at any time will have no consequences. If developmental delay or sensory modulation deficits are identified, the participant will be contacted and referred to the rehabilitation professionals for intervention.

Please feel free to contact myself or my supervisor Mrs Lizelle Jacobs with any queries on (011) 717 3701. If you have any ethical concerns please feel free to contact HREC administrator and chair from the Wits Research office on (011) 7171234.

Many Thanks

Nicole Paul

Occupational Therapy

0834301627

PERMISSION TO CONDUCT RESEARCH

I, Takalani Nanny Mugeri, Head of the Occupational Therapy Department, give my consent to use the Occupational Therapy Department in the study *"The association between demographic/environmental factors and development and sensory modulation in preterm infants"*.

I understand that confidentiality is ensured.

Signature ____________________

Date 08/06/2016

APPENDIX L Experts assignment of sensory processing systems

Measurement Criteria	Is a uterine-like environment created for each infant to support and environment conducive to growth and optimum development	**Individualised care: observation**	The caregiver reads the infant's cues and behaviours	The staff responds to infant cues and behaviours	The caregiver continuously and systematically assess and evaluate the infant's developmental needs	Care is adapted according to cues and behaviours.	Care is provided according to the infant's individual developmental maturity	Autonomic, motoric, and behavioural cues are identified and used to support individualised caregiving.
GP	X			X		X	X	X
AP								
VP								
TP								
MP								
OP								

Measurement Criteria	**Family centred care**	Parents see their infant immediately after birth	Parents touch their infant immediately after birth	Parents hold their infant	Parents are involved with care, e.g. feeding, bath, KMC.	Parents are allowed to personalise their infant's bed space	Mother's are encouraged to express milk for their infant, or to breastfeed.	Discharge training commenced	Nursery atmosphere is warm, comfortable and soothing with a homelike appearance	Privacy is provided for parents	Information is shared between professionals and parents regarding their infant's developmental needs.	Parents are allowed to visit at any time	Siblings may visit	The facility has parent support groups
GP					X			x	X					
AP				X	X									
VP					X									
TP			X	X	X									
MP				X	X									
OP				X	X									

Measurement Criteria	Positioning	Infants are positioned anatomically with the neck in a neutral position, shoulders protracted, body symmetric, knees flexed with hips and arms in midline. This state is reached with the use of containment and firm boundaries.	The infants are contained	The infants have firm boundaries that fit snugly	The body position is symmetric	The neck is in neutral position with the head in midline in line with the body.	The shoulders are protracted	The arms are in midline.	The knees are flexed	The hips are flexed in a neutral position with some adduction	Infant is kept in flexion (limbs and shoulders) during positioning and postural support.	Prone or side-lying positions are rather used than supine, especially in acutely ill infants	Individualised bedding is used to position infants.
GP		X	X	X	X	X	X	X	X	X	X	X	X
AP													
VP		X	X										
TP		X	X	X									x
MP		X	X			X	x	x	X	X	X	x	
OP													

Measurement Criteria	Handling techniques	Care changes as infants matures.	The care giver supports gradual state changes by using transitional touch.	The infants receive at least 2-3 hours uninterrupted sleep	The unit has quiet times where all routine cares and interventions are delayed.	Care interventions are clustered around sleep.	Calm, gentle containment and facilitation is provided during handling procedures to support flexion.	The infant is provided with "time-out" or rest periods according to his/her cues	Direct hands-on-caregiving is modified by providing positive tactile stimulation.	Positive tactile stimulation is provided, including stroking or gentle massage if applicable.	Containment or still hold is provided.	Parents are allowed to do skin-to skin care with their infants within 24-48 hours (2), after 48 hours (1) never or no proof of skin-to-skin (0)	Preterm infants are swaddled.	Preterm infants are moved slowly, as a whole, keeping the body and head aligned and limbs tucked in.
GP		X	X	X	X	X		X	X	X		X	X	X
AP		X		X	X	X		X				X		
VP		X		X	X	X		X				X		
TP		X	X	X	X	X	X	X	X	X	X	X	X	X
MP		X		X	X	X	X	X			X	X	X	X
OP		X		X	X	X		X				X		

Measurement Criteria	**Handling techniques continued**	Appropriate soft bedding is used	Multiples are co-bedded. Always (2) if stable (1) never (0)	Self-regulation of infants are promoted.	Infants are provided with opportunities for grasping.	State regulation is promoted.	Non-nutritive sucking is provided to support self-regulation
GP			X	X	X	X	X
AP			X				
VP			X				
TP		X	X		X		X
MP			X				
OP		X	X		X		

Measure-ment Criteria	**Environmental manipulation**	Reduction of Noise	No radio or stereo equipment used in the unit, telephones away and rings softly.	Doors and drawers are padded to reduce noise	Bottoms of trash cans are padded/lids with peddle bins padded	Sound levels are measured and kept below 45dB	Soft music is used where appropriate.	Infant beds are placed away from traffic	There are effective sound absorption in infant spaces e.g. curtains, wall hangings or padding.	Monitor alarms are kept at a safe minimum volume or set to vibrate /flashing	Staff respond to alarms quickly	Noise reduction incubator covers are used.	Soft ear plugs or covers are used.	Closed incubator portholes are closed quietly by using the latch	Sound levels are measured in the incubator
GP			X	X		X	X		X	X	X	X	X		X
AP			X	X	X	X	X	X	X	X	X	X	X	X	X
VP															
TP													X		
MP															
OP															

Measurement Criteria	Ventilator tubes are emptied regularly, no water build-up	Minimal background noise at the infant	Charts and stock items are placed next to incubators not on top.	Staff keep their voices down and away from the infant's bedside	**Reduction of light:**	Ambient light is reduced/ dimmed	Blinds are closed during daylight hours	Activity levels are kept as low as possible	Incubator covers are used with closed incubators	Direct bright light is avoided	Bedside lights are titrated/ controlled	Light levels inside incubators are measured	Eye protection is used with phototherapy	One source of daylight is used with a shading device
GP	X	X		X				X	X					
AP	X	X	X	X										
VP						X	X	X	X	X	X	X	X	X
TP													X	
MP														
OP														

Measurement Criteria	Overhead lights are dimmed	Procedures are kept to a minimum to ensure minimum handling	Toys, pictures and appropriate music used to reduce sensory monotony	The unit provides cycled light	Day/night cycle is provided with 12 hours of low light and sound at night	**Olfactory**	Positive olfactory stimulation is provided, such as mom's smell inside the incubator.		**Pain management non-pharmaceutical**	Oral glucose is effectively and correctly administered as pain management option	Non-nutritive sucking is provided during painful minor procedures
GP		X	X		X						X
AP			X		X						
VP	X	X	X	X	X						
TP		X	X								
MP		X	X								
OP			X				X				X

Measurement Criteria	**Knowledge of infant development**	Staff attended training and are able to read infant cues and behaviours	Knowledge is shared between professionals	The unit applies a multidisciplinary team approach	Parents are taught preterm infant behavioural cues and stress signs.	Parents are taught how to interact with their preterm infant based on the cues and behaviours.	**Feeding infants**	Preterm infants are prepared for feeding.	Preterm infants are positioned in a way that prevents the need for repositioning after a gavage feed.
GP						X		X	X
AP								X	
VP								X	
TP								X	X
MP								X	X
OP								X	X

APPENDIX M Turnit in Report

ENVIRONMENTAL FACTORS, SENSORY MODULATION AND DEVELOPMENT OF PRETERM INFANTS IN THE NEONATAL HIGH CARE UNIT

ORIGINALITY REPORT

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