THE COGNITIVE PROCESSING POTENTIAL OF INFANTS: A STUDY OF THE EFFECT OF EARLY INFANT EXPOSURE TO NUMBERS, SHAPES AND COLOURS

by

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Declaration

I, Jacqueline van Vuuren, declare that this dissertation, “The cognitive processing potential of infants: a study of the effect of early infant exposure to numbers, shapes and colours”, is entirely my own written work, except where otherwise credited, the sources that have been used or quoted have been indicated, and acknowledged to the best of my ability by means of complete references. I further declare that I have not previously submitted this work, or part of it, for examination at UNISA for another qualification or at any other higher education institution.

Jacqueline van Vuuren : ______________________ Date : ________________

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"*As a mother comforts her child, so I will comfort you*."

(Isaiah 66 v 13)

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Summary

Intellectual stimulation of young children is crucial, because it helps to break the cycle of poverty by giving each child the skills needed to reach his or her maximum potential. There is a growing need for more extensive early childhood development programmes in South Africa. Several studies in early childhood development have been shown to directly draw a parallel with enhanced student achievement at school and in life (Ackerman, 2005; Bueno, Darling-Hammond, & Gonzales 2010; Frede, Jung, Barnett, & Figueras, 2009). This study therefore explored the effects of an intervention programme introducing numbers, shapes and colours to infants between the ages of three months and 12 months.

The sample consisted of 63 infants, with a control group of 34 and an experimental group of 29. The participants were selected from the middle-income group and consisted of infants from three different ethnic groups (black, white and coloured). Nine participants from the experimental group formed part of the focus group, which met every two weeks to give feedback and discuss the development of the infants and experiences of the parents involved in the intervention programme.

In this study quantitative and qualitative data was collected. This data was assessed and analysed in order to achieve the four aims of the research study. The Bayley Scales of Infant Development (III) was used to assess three areas of development, namely cognitive ability, language skills and motor skills for the quantitative part of the study. The adaptive behaviour and social-emotional functioning of the infants was also assessed using the BSID (III), and this data was used in conjunction with the focus group feedback and problem-solving scenarios for the qualitative part of the study.

Gender and the two age categories (3–7 and 8–12 months) for both the experimental and the control groups were examined and excluded from possible explanations for any significant findings. It was also determined that the control and experimental groups were well matched at the start of the intervention programme.

The findings for aim A, the pre-test and post- test results showed that an average of 60 days involved in intervention programme had a statistically significant effect ($z = -4.32$, $p < 0.001$) on the cognitive ability of the infants.

The findings for aim B, for the comparison between the control and experimental groups after the intervention programme, indicated significant results for the cognitive subscale ($U = 732$, $p < 0.01$, $r = 0.42$). Although the language and motor scores showed an increase in the descriptive statistics for the experimental group after the intervention, the Mann-Whitney U test did not show a significant difference.

The findings for the qualitative study for aim C revealed that there was no effect on the adaptive behaviour of the infants.

The findings for the social-emotional scales descriptive statistics for the qualitative study in aim D showed that there was a fairly large increase in the composite score means of the experimental group in comparison with the control group. The large increase in results complements the social-emotional functioning theme that emerged from the focus group.

Three main themes emerged from the focus group, namely the cognitive ability, communication skills and social-emotional functioning of the infants.The increase in the social-emotional scale for the intervention group and the increase in the cognitive scale as mentioned in aim B were interrelated. These early social-emotional experiences are linked to long-term positive outcomes in both the social and cognitive areas of development (Landry, Smith, Swank, & Miller-Loncar, 2000). The parents all reported the ability to interpret the communication from their infants when participating in the flashcard sessions. This communication forms a foundation for establishing language development. Relationships between an infant’s nonverbal communication skills and subsequent language development have been reported (Brooks & Meltzoff, 2005).

The problem-solving scenarios that were assessed during the second assessment showed that the infants who participated in the intervention programme were able to correctly identify a flashcard 73% of the time in comparison with the control group who were only able to identify a flashcard 1.4% correctly.

The results of the study show that an early intervention programme has the potential to increase an infant’s cognitive ability and enhance his or her social-emotional functioning. However, the long-term impact of these findings would have to be explored in a longitudinal study.

CHAPTER 1

INTRODUCTION

This study in psychology focuses on the visual and sensory developmental stage of the infant's brain. The main objective of the study was to determine the effects of infant exposure to numbers, shapes and colours at such an early stage of development.

Many challenges face a developing country such as South Africa. These challenges have the potential to affect the development of infants and children negatively (Saloojee & Pettifor, 2005). It is not possible to eliminate all the risks, but appropriate assessment and early intervention programmes can help the development of these children and afford them better future opportunities.

The development of an infant usually follows a set pattern. A process of learning takes place and milestones are achieved at specific periods of the infant's life. Infants may deviate slightly from normal development and these deviations may be the result of many risk factors that influence development (Aina & Morakinyo, 2005). Developmental assessment of infants can assist in early detection of problems and initiate early intervention. It is essential, however, that the appropriate assessment is selected (Johnson & Marlow, 2006). Vygotsky believed that social interaction plays a key part in the process of cognitive development. Social situations create a platform for infant learning, especially cognitive and cultural development (Vygotsky, 1978). An intervention programme for early infant exposure to numbers, shapes and colours should therefore ideally include regular parent and child interaction.

1.1 PROBLEM STATEMENT

The family is an important unifying force in society and plays a central part in social cohesion (Furstenberg & Cherlin, 1991). "The family is the nucleus of society, and when it weakens or crumbles the stability of the entire community is adversely affected. It is thus imperative to initiate and co-ordinate resources to maintain a healthy and happy marriage and family life" (http://www.famsa.org.za/; Bauermeister, 2012).

Studies on the development of skills in infants and young children have indicated that stimulation in the early years is one of the rare examples of interventions that are both fair and efficient. Interventions that focus on early stimulation reduce inequalities and raise the productivity of society as a whole (Heckman, 2006). Interventions that start later in life need remediation of developmental delays. The disadvantages and challenges in developing countries such as South Africa cause developmental delays. The interventions that start later in life are more costly and less effective. Stimulation and positive participation early in infant development can therefore increase the effectiveness of later interventions (Heckman, 2006).

South African society has seen marked transformations in the social and economic circumstances under which families are raising young children. The increased statistics in crime, HIV/Aids, or even just the need for survival, are leaving scars on the development of our small children (particularly in underprivileged areas). An increasing number of mothers are working to help support the family. International research has shown that 50 to 58% of mothers of infants and 69% of mothers with preschool children work (Klass, 1999). In a South African study of joint reading between mothers and infants (0 to 2 years old), 60% of the mothers worked (Kritzinger & Louw, 1997). This increase in households where both parents are working means that parents are left with little time for stimulating their infants. It is becoming increasingly common for infants to be looked after by someone other than the mother.

Aids, divorce, poverty and lack of parent supervision mean that children in these circumstances are constantly at risk of exposure to abuse, death and sickness. Educational stimulation is understandably not a priority, but can be the key to creating a better future. Research provides information on types of therapy and psychological interventions such as counselling and remedial education to help children cope with the experiences of difficult lives and educational struggles at school (De Bellis et al., 1999). However, the aim of these programmes is to fix the problem and not to prevent it in the first place (Heckman, 2006). Intervention programmes that provide therapy and remedial education are costly, and are often implemented too late in the child's life. Stimulation of infants for cognitive development, along with other support programmes, can help to develop a more cost-effective way of decreasing educational, social and psychological problems. Early intervention and intellectual stimulation can thus lay the foundation for a better educational future.

Intellectual stimulation of young children is imperative, because it helps to break the cycle of poverty by giving each child the skills needed to reach his or her maximum potential. There is a growing need for more extensive early childhood development programmes in South Africa. Several studies in early childhood development have been shown to directly correlate with enhanced student achievement in school and at life (Ackerman, 2005; Bueno, Darling-Hammond, & Gonzales 2010; Frede, Jung, Barnett, & Figueras, 2009). While government policies on many levels recognise the importance of this development, there is presently no standardised system for supporting these programmes in our country. There are funding limitations and a lack of public facilities for early childhood activities. Limited community participation in these programmes is a major concern for South Africans (Department of Education, 2001).

In certain communities, there are community projects to help infants and children at emotional, medical and nutritional level. However, these existing projects and programmes do not necessarily provide intellectual stimulation. The purpose of this particular research project was therefore to approach the problem from an intellectual support perspective. Programmes that start working with families as soon as the babies are born have been proven effective in preventing abuse and neglect, giving babies a better educational foundation (MacMillan, MacMillan, Offord, Griffith, & MacMillan, 1994).

1.1.1 Infant development

Development is defined as "orderly and relatively enduring changes over time in physical and neurological structures, thought processes, and behaviour" (Mussen, Conger, Kagan, & Huson, 1984, p. 4). Infant development is the process of learning and mastering skills known as developmental milestones. These developmental milestones are typically reached at predictable times (see appendix 4). A typical infant will follow a pattern of development based on these developmental milestone norms. It should be noted that there is a range in development of infants, and it is not uncommon for infants to deviate slightly from the norm, depending on the specific type of population (Papalia, Wendkos Olds, & Duskin Feldman, 2009; Richter, Griesal, & Rose, 1992). From birth, an infant's development can be categorised into five main areas, namely cognitive, social and emotional, speech and language, fine motor skills and gross motor skills.

Infant developmental norms and categories help to provide insight into typical infant development. There are many factors that influence infant development (Richter et al., 1992). The knowledge of infant development, together with assessment, helps to detect problems early in life (Johnson & Marlow, 2006) and therefore fosters an understanding of various factors that influence infant development. This knowledge can also be used to establish a platform that initiates early intervention to afford infants the opportunity to reach their full learning potential.

The brain is the most immature organ at birth and continues to grow and develop after birth. The brain relies on the influences of a combination of genes, the environment and experiences to develop and grow. In most regions of the brain, no new neurons form after birth. According to Huttenlocher & Dabholkar (1997), brain development therefore depends on the continuous stimulation of connections between the neurons of the brain (Huttenlocher & Dabholkar, 1997).

“Genetics supply a basic plan for brain development which instructs the properties of the nerve cells and lays down basic rules for interconnecting the neurons. In this way genes provide the initial construction plan for the brain’s architecture” (National Scientific Council on the Developing Child, 2007, p.2). According to Huttenlocher & Dabholkar (1997), through the connection of these neurons, the brain stores information that has been stimulated by experiences, including early learning experiences.

These early learning experiences have a vital influence on the structure of the brain, because the connections of the neural pathways develop until maturity. After maturity, any modifications in learning are limited and more difficult. It is therefore essential that the right experiences occur during these ”sensitive periods”: as they are essential in shaping the capacity of the brain. “Different neural circuits pass through sensitive periods at different ages” (National Scientific Council on the Developing Child, 2007, p.1). These sensitive periods for the connection of the neural pathways play a vital part in forming future learning foundations (National Scientific Council on the Developing Child, 2007).

The last two decades of research in infant development have seen dramatic changes in the way developmental psychologists characterise the earliest stages of cognitive development. The infant, once viewed as an organism motivated mainly by simple sensorimotor schemes, is now perceived as having sophisticated cognitive skills, and makes use of complex concepts to guide knowledge acquisition (Madole & Oakes, 1999).

Cognitive development is the process of growth and change in skills such as thinking, reasoning and understanding. It includes the acquirement and consolidation of knowledge. Infants depend on their social, emotional, language, motor and perceptual experiences and abilities for cognitive development. Infants are mainly interested in learning from people, even though they start to understand connections between features of objects, actions and their surrounding environment. Parents and caregivers play a crucial role in supporting the cognitive development of infants (Madole & Oakes, 1999).

Research shows that infants who show pronounced cognitive competence are usually the most active, motivated and involved (Shankoff & Phillips, 2000). These infants learn through exploration (Whitehurst & Lonigan, 1998), show a natural curiosity and have a strong drive to learn.

Experiences that occur on a daily basis, such as the infant crying and then being picked up or waving a toy and then hearing it rattle, afford infants an opportunity to learn consequences from their actions. “Even very young infants possess expectations about physical events” (Baillargeon, 2004, p. 89). The acquisition of this knowledge helps infants to understand certain concepts such as the properties of objects, the patterns of human behaviour and the relationship between events and the consequences of these events. In this way, infants increase their cognitive capabilities to solve problems, make predictions and understand the impact of their behaviour on others.

In studying the effects of early infant exposure to numbers, shapes and colours, an understanding of the developmental stages of the brain was required. In this way, in the current study, the intervention programme could be introduced to the infants at an age where many of the ”sensitive periods” overlap (see Figure 1.1).

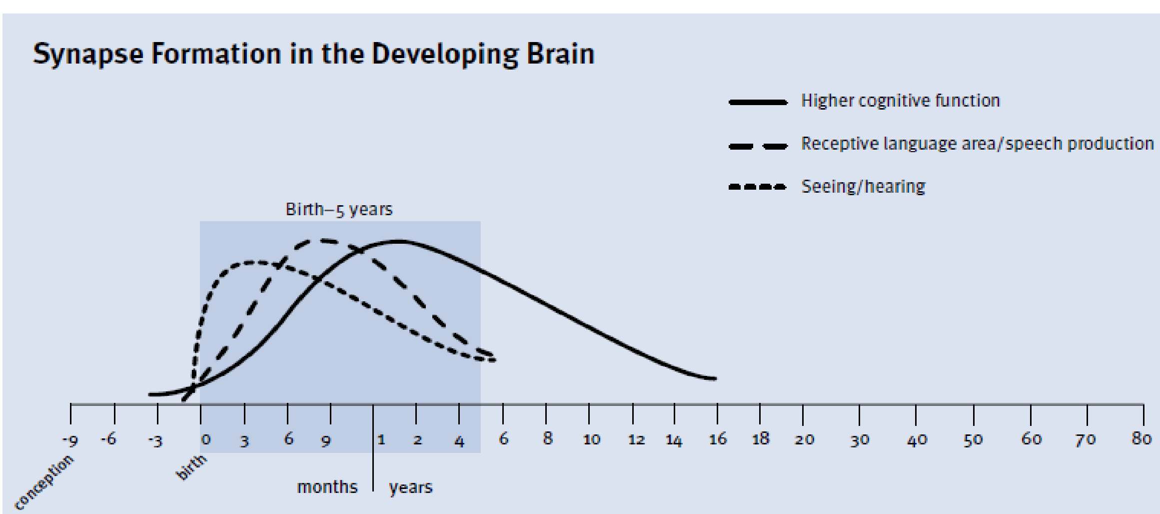

Figure 1.1: Synapse formation in the developing brain (s*ource*: Nelson, 2000)

The way infants develop cognitively played a significant role in the presentation and development of the intervention programme, which was used in the present study. Special attention was paid to imitation, problem solving, memory, number sense, and classification and attention maintenance (Halberda, Mazzocco, & Feigenson, 2008). These specific areas in cognitive development can be seen as the foundation for understanding numerical concepts and are important in the introduction of numbers, shapes and colours.

1.1.2 Social context and educational foundation in South Africa

South Africa is a country with great diversity and has many different cultures, languages, political affiliations and levels of social class. Social context in the improvement of educational opportunity in South Africa plays a key role. Negative social influences such as poverty, unemployment, crime and violence are prevalent in many communities and invariably affect the learning process and therefore impact on children's educational experiences and outcomes. International research indicates that inadequate housing, health care and nutrition, as well as unemployment and unsafe environments, all have negative effects on the learning and development of children (Duncan & Brooks-Gunn, 2000).

In South Africa, the estimated total population in the middle of 2011 was 50.59 million. The black population constituted just over 79% (40.21 million) of the total South African population. The white population was estimated at 4.57 million, the coloured population at 4.54 million and the Indian/Asian population at 1.27 million (http://www.statssa.gov.za/publications/P0302/P03022011.pdf).These numbers are illustrated in Figures 1.2 and 1.3.

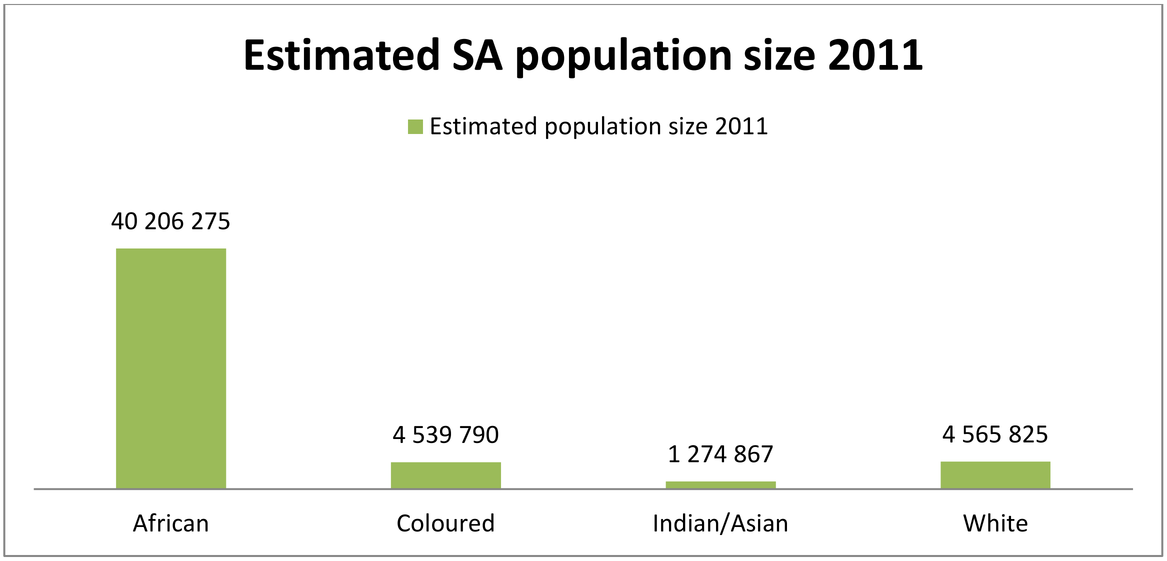

Figure 1.2: Estimated population size, 2011 (*source*: http://www.statssa.gov.za/publications/P0302/P03022011.pdf)

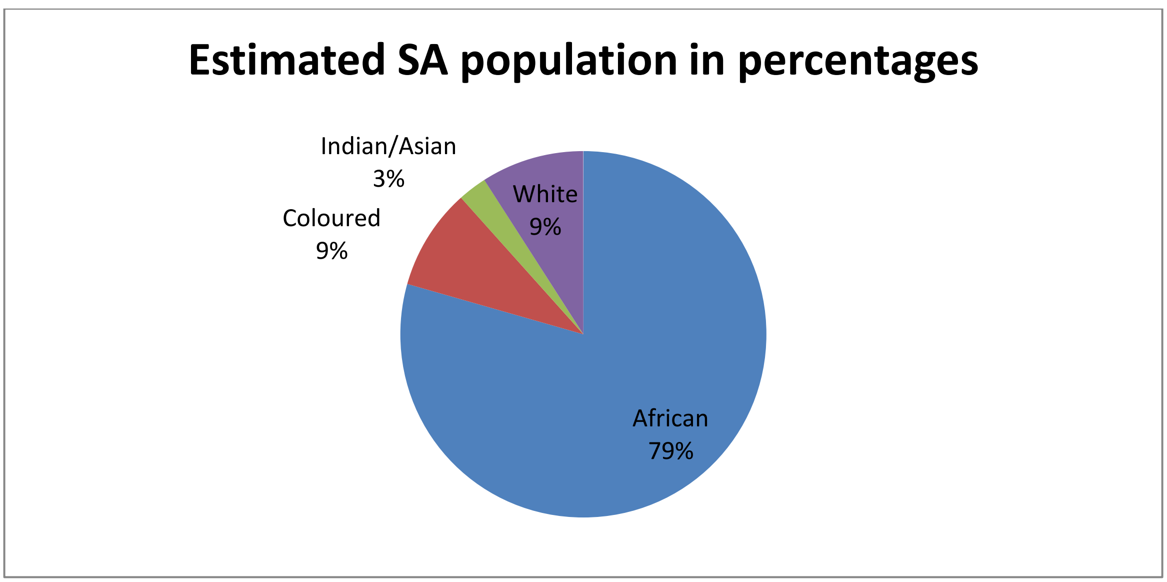

Figure 1.3: Estimated South African population in percentages (*source*: http://www.statssa.gov.za/publications/P0302/P03022011.pdf)

Children from birth to four years of age represent 10% of the total South African population (Statistics South Africa, General Household Survey, 2002–2009). This means that there is an estimated total population of 5 189 528 children under the age of four across all racial groups that can be reached to facilitate early learning potential during the most critical brain development time. Only 29.4% of these zero- to four-year-olds attend an educational institution (Statistics South Africa, General Household Survey, 2002–2009). Considering this fact and the impact of social influences on learning and development in children, it is essential to formulate and provide proper developmental assessment and early intervention programmes. Information received from the assessment measures, will be used to identify disabilities and design appropriate intervention programmes (Luiz, 1994; Hale, 2006).These programmes need to be accessible in ways other than through educational institutions for zero- to four-year-olds. The population size of South African children between birth and four years of age is illustrated Figure 1.4. This indicates the number of children in this category that could potentially be reached through early educational intervention. In the present study, the focus was specifically on the assessment and intervention of infants from three to 12 months.

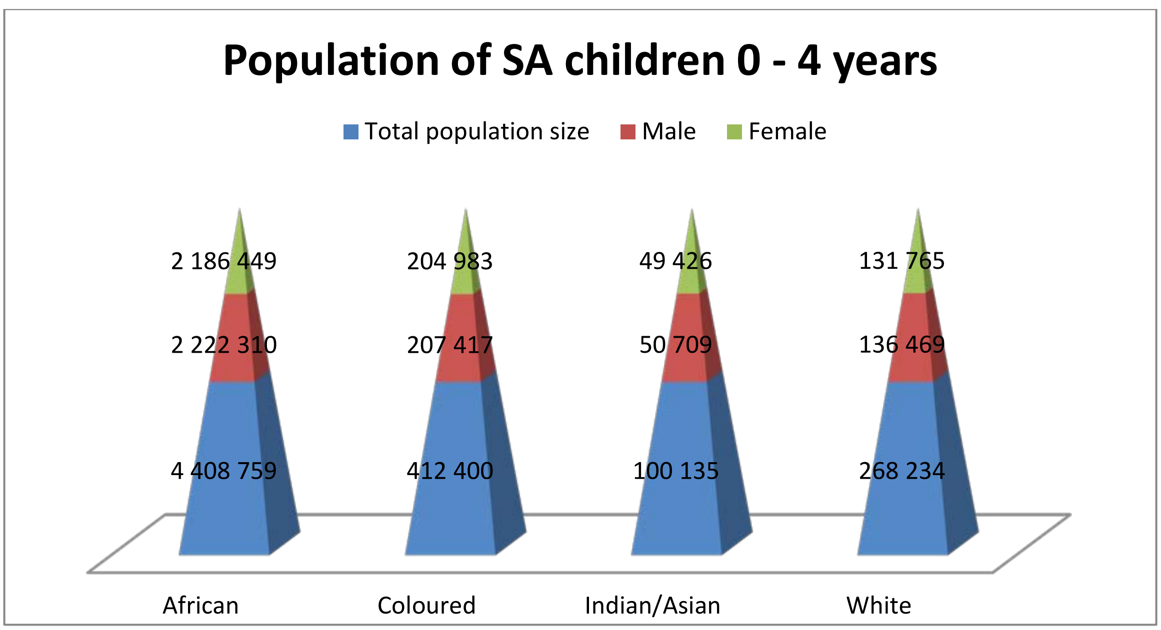

Figure 1.4: Population of South African children, birth to four years old (*source*: http://www.statssa.gov.za/publications/P0302/P03022011.pdf)

The educational system in South Africa has systematically been expanded to encourage learners to stay in school until the Grade 12 level, but the quality of schooling in South Africa still requires much improvement. According to a UNICEF South African report (2011), education achievement levels are lower than in many other Third World countries. Many South African children experience a broken journey through school owing to irregular attendance, absent teachers, teenage pregnancy and school-related abuse and violence. According to the UNICEF South African report (2011), 27% of public schools do not have running water, 78% are without libraries and hardly any provision is made for educating preschool children. The Department of Basic Education has formulated plans to improve learner achievements by means of Annual National Assessment, hoping to provide regular and credible data on learner achievement and inform decision making in the education system (UNICEF South Africa, 2011). The assessment in 2011 involved numeracy and literacy tests among six million foundation phase (Grades 1 to 3) and intermediate phase (Grades 4 to 6) learners at government schools. The findings revealed that the quality of teaching is poor, resulting in low performance. The percentage of learners reaching a ”partially achieved’’ level of performance varied from 30 to 47%, depending on the grade and subject that was assessed. Those attaining the ”achieved” level of performance varied from 12 to 31% (UNICEF South Africa, 2011). This confirms Bloch’s (2009) view that the results in South Africa for literacy, numeracy and science remain low, even in comparison with underdeveloped and less-resourced African countries. The learners in underprivileged schools are at more of a disadvantage than the learners in privileged schools (Bloch, 2009). “In recognising the deep-seated crisis in education, in his 2010 State of the Nation address, President Jacob Zuma announced government’s commitment to place education and skills development at the center of its policies. He declared government’s intention to improve the ability of children to read, write and count during their foundation years” (Motshekga, 2010).

1.1.3 Developmental assessment in South Africa

In South Africa, developmental assessment and the assessment tools used for assessment need to consider the country's political, economic and social history (Claassen, 1997). The context of South Africa is both unique and complex, which creates challenges in the field of psychological assessment and the development of psychological tests (Claassen, 1997; Foxcroft, 1997).

The assessment of children in South Africa is vitally important, as well as recognition of the fact that children from various cultural backgrounds need to be assessed. South African children learn in a diverse, multicultural setting, indicating that there is a need for a ”culture-reduced” developmental assessment that will allow for ”culture-fair” assessment (Allan, 1992) of infants in South Africa.

Different assessment methods are used to assess the development of a child. The assessment tools vary according to the method of assessment and requirements for the specific assessment. Assessments can include developmental screening and diagnostic testing and differ in their psychometric properties (Johnson & Marlow, 2006).

Screening tools are more convenient and affordable than diagnostic assessment tools. Screening tools can be administered by almost anyone (Aina & Morakinjo, 2005). Diagnostic assessment tools are more expensive and require specific training for administration and scoring. Diagnostic tests are usually standardised, allowing comparison of the individual child's development with that of the norm. These tests are structured and objective (Johnson & Marlow, 2006). Standardised assessments tend to be based on the population of the country of origin of the test and may not be appropriate for use with all populations (Aina & Morakinjo, 2005) owing to potential social, economic, cultural and biological differences (Walker et al., 2006). These differences all influence infant development (Walker et al., 2006). Hence what is considered the norm for one country may not be the norm for another (Aina & Morakinjo, 2005). Outdated norm sampling and research can also have negative effects on the results of an assessment. It is necessary to use assessment tools for the correct purpose (Johnson & Marlow, 2006).

Diagnostic tests allow for accurate assessment of infant development. They classify developmental delays and can indicate appropriate interventions (Johnson & Marlow, 2006).

The Griffiths Mental Scales (Griffiths), the Bayley Scales of Infant Development (III) (BSIDIII), the Batelle Inventory (Batelle), the Developmental Assessment of Young Children (DAYC), and the Denver Developmental Screening Test (Denver) are all examples of standardised assessments for child development. These overseas assessments were used for local studies, as discussed below. The Griffiths Scales for the ages birth to 23 months were used to assess the performance of nine-month-old infants in a study that compared the development of South African infants to that of British infants (Von Wielligh, 2012). A study conducted in Johannesburg used the BSID (II) to assess the development of children between 18 and 30 months who were infected with the human immunodeficiency virus (HIV). The Developmental Assessment of Young Children (DAYC) and the BSID were compared in a study for South African deaf infants, between the ages of one to five months (Clayton, 2008). Internationally, the BSID (III) assessment measure is the most extensively used and has the most recently updated norms. The BSID (III) was standardised in 2006 and normed in the USA. The BSID (III) is known for its brilliant psychometric properties when assessing the development of infants (Harris, Megens, Backman, & Hayes, 2005).

The assessment of infants requires a comprehensive assessment tool, because the different areas of development in young children overlap. Developmental assessments that have been standardised for infants in South Africa are not always comprehensive (Luiz, 1994; Van der Merwe, 2002). According to Patterson and Uys (2005), a comprehensive overview of the tests currently used in South Africa and the requirements for future development in psychological assessment is not available at present (Patterson & Uys, 2005). According to a report by Oakland (2004), an international survey of 29 countries revealed that countries have different views in terms of their approach to psychological testing (Oakland, 2004). Assessments that do not take into consideration the cultural influences of a child's development and the origin of the assessment measure may have many negative implications. There is a need for more research in the development of assessments for the South African context, or adaptation and standardisation of appropriate tests from other countries. These assessments need to be valid and reliable. They need to cover all the important aspects of development, specifically for the age category of birth to three years. The development of such a test could be costly and challenging. This, however, was not the aim of the present study. An existing culture-fair assessment that is used worldwide and user friendly for the population diversity that exists in our country (Bhamjee, 1991; Luiz, 1994), was used to determine the effect of the intervention programme.

The Bayley Scales of Infant Development (BSID) is the most frequently used assessment of infant development in the world with 44 published studies that have used the BSID outside of the USA. The BSID (I) was normed on a South African population, taken from both urban and rural areas, and was found to be suitable for use on South African infants (Richter & Griesel, 1988). Although a need exists for studies that are more recent on the South African population, the BSID is the most widely used measure of early development (Black & Matula, 2000). The BSID has proven sensitive to a variety of different interventions (Black & Matula, 2000). The BSID (III) is therefore the assessment tool used to determine the effects of early infant exposure to numbers, shapes and colours.

1.2 RESEARCH QUESTION AND AIM

The following research question was formulated for this study: *What is the effect of infant exposure to numbers, shapes and colours at an early stage of development?*

The study introduced an intervention programme to infants using numbers, shapes and colours. This programme lays an educational foundation through parent involvement. The objective of this study was to examine if early infant exposure to brain stimulation in the form of flashcards with numbers, shapes and colours increases the infant's cognitive processing potential.

1.2.1 Quantitative aims

The BSID (III) was used as an assessment measure to determine if there was a difference

(a) in the experimental group's mean composite scores for each subscale (cognitive, language and motor development) before and after the intervention programme

(b) between the infants in the experimental group's and control group's mean composite scores for each subscale (cognitive, language and motor development) before and after the intervention programme

1.2.2 Qualitative aims

The qualitative aims of the study were to determine if there was a difference in the

(c) adaptive behaviour of the experimental group owing to added stimulation from their parents by means of the programme, before and after the intervention programme, when compared to the control group

(d) social-emotional behaviour of the experimental group owing to added stimulation from their parents by means of the programme before and after the intervention programme when compared to the control group

The qualitative aims helped to determine if there were any behavioural or social emotional changes resulting from parental involvement and the additional stimulation the intervention programme provided, through observation of the infants' social and emotional behaviour.

1.2.3 Research hypotheses

The research hypotheses for the above aims are indicated below.

1.2.3.1 Hypotheses for aim (A)

The null hypothesis (H0):

There was no difference in the mean composite scores for each subscale in the experimental group before and after the intervention programme.

The alternative hypothesis (H1):

There was a statistically significant difference in the mean composite scores for each subscale in the experimental group before and after the intervention programme.

1.2.3.2 *Hypotheses for aim (B)*

(1) The null hypothesis (H0):

There was no difference between the experimental group's and control group's mean composite scores for each subscale before the intervention programme.

The alternative hypothesis (H1):

There was a statistically significant difference between the experimental group's and control group's mean composite scores for each subscale before the intervention programme.

(2) The null hypothesis (H0):

There was no difference between the experimental group's and control group's mean composite scores for each subscale after the intervention programme.

The alternative hypothesis (H1):

> There was a statistically significant difference between the experimental group's and control group's mean composite scores for each subscale after the intervention programme.

Since age and gender have an impact on development, the effects of these factors before the intervention programme were also considered. Investigation of these two factors helped to exclude them as possible alternatives for the answers from the data analysis.

1.3 RESEARCH DESIGN AND METHOD

The quantitative aims were achieved through an experimental research approach that involved the assessment of an experimental group and a control group before and after the intervention programme. To achieve the qualitative aims of the research study, a descriptive research approach was used. The combination of qualitative and quantitative research ensured a richer source of data collection and analysis.

The research design involved four phases. The first two phases involved a preplanning stage and a qualitative pilot study which helped determine and identify factors in order to develop an appropriate foundation for the research study. The third and fourth phases of the study involved the quantitative and qualitative phases. This required the assessment of the infants participating in the study by a professional using the BSID (III) and collecting information from a focus group.

Purposive sampling was used for study. The researcher made decisions about which respondents to choose, based on the selection criteria, selecting only those who best met the purpose of the study. The advantage of purposive sampling is that researchers can use their skills and knowledge to select appropriate participants (Bailey, 1987). The sample in this study comprised of infants from different race groups. South Africa is predominantly made up of three ethnic groups, black, white and coloured and for this reason infants were selected from these racial groups to participate in the study. The infants all came from the middle-income sector as determined by the guidelines for middle class (see Appendix 1). The sample consisted of 63 infants between the ages of three and 12 months, with a control group of 34 infants and an experimental group of 29 infants. Nine participants from the experimental group formed part of the focus group. The sample chosen was one of convenience based on infants who were available and fulfilled the inclusion criteria.

The data was analysed using nonparametric tests (because the sample size was less than 100 participants). The Mann-Whitney U test and the Wilcoxon signed-ranks test were used. The data was analysed using the IBM SPSS 22 software package.

1.4 CHAPTER LAYOUT

Chapter 2 is the literature review. The typical developments of infants are discussed with the focus on cognitive development and cognitive theorists as well as motor development. Factors that affect child development are also explored. This chapter highlights a number of different assessment measures used for infants and young children with special emphasis on the BSID (III). The chapter also outlines studies on infant learning and the basis for the intervention programme. Chapter 3 includes the methodology employed in conducting the study and the process used to analyse the results. Chapter 4 provides a discussion of the results. A critical evaluation and the conclusions of the study are presented in Chapter 5.

SUMMARY

South Africa is a Third World country that faces its own unique set of challenges such as poverty, illness and abuse. These risks can potentially have a negative impact on the development of children (Saloojee & Pettifor, 2005), including the effect on children’s ability to learn at school. There is an estimated total population of 5 189 528 children under the age of four across all racial groups in South Africa (Statistics South Africa, General Household Survey 2002–2009), that can be reached. Although, it is not possible to eradicate all the risks, suitable assessments and early intervention programmes could promote the development of these children.

The typical stages of development usually follow a set pattern, and any deviations from these patterns may be the result of the many risk factors that influence development (Aina & Morakinjo, 2005). Assessments that measure the development of infants assist in early detection of developmental problems and introducing appropriate intervention programmes. The suitability of the assessment measure is crucial for accurate detection of developmental problems (Johnson & Marlow, 2006).

The BSID (III) was used to assess 63 infants between the ages of three and 12 months, with a control group of 34 infants and an experimental group of 29. A comparison of the results from the BSID (III) was made between the two groups, to determine the effects of early infant exposure to an intervention programme of numbers, shapes and colours. The results were analysed using nonparametric tests, the Mann-Whitney U test and the Wilcoxon signed-ranks test. A focus group of nine parents and infants from the experimental group met every two weeks to gather information for the qualitative part of the study.

CHAPTER 2

LITERATURE REVIEW: INFANT DEVELOPMENT, ASSESSMENT AND INTERVENTION

Infants develop from being helpless and dependent and requiring complete care to becoming self-sufficient and independent individuals. This process of development refers to acquiring skills in different developmental areas, namely cognitive, language, motor and social skills. The developmental skills that are attained as the infants reach predictable stages are known as milestones (Lima, Eickmann, Lima, Guerra, Lira, Huttly, & Ashworth, 2004).

Infants with suspected delays should be tested for these suspected developmental delays. Early identification of problems allows for early intervention (Johnson & Marlow, 2006). Programmes can thus be implemented and interventions suggested to help infants mature and afford them opportunities to reach their full developmental and educational potential.

Physical and social environmental factors and individual child characteristics all influence development (Walker et al., 2007). These factors play a crucial role, because they can affect development negatively or positively. In order to assess development in infants to determine if there are any delays or to implement programmes and interventions to enhance development, the appropriate assessment is necessary. Sound knowledge of infant development is required. Diagnostic assessment tools are ideal measures to provide accurate information. Standardised tests are intended to assess infant development according to data collected from the country in which the test originated. This data is used to create norms to be used as the basis for the comparison of individual scores to the norms (Johnson & Marlow, 2006).

South Africa is a developing country that faces many challenges. The infants of South Africa are at risk, because of these various challenges, and South Africa requires a suitable tool to assess these young children and identify appropriate intervention programmes if needed.

2.1 INFANT DEVELOPMENT

The process of development in the first few years of an infant's life is based on the average rate of advancement that young children achieve in terms of cognitive and motor abilities. These milestones are predictable stages and can be used to describe the typical development in young children. Comparisons can be made between actual development and milestone achievement age ranges (Lima et al., 2004). Development can be observed in terms of cognitive abilities, language acquisition, social skills, fine motor skills and gross motor skills. Development can be affected by a number of different elements that should always be taken into consideration when making comparisons to milestone achievement norms (Richter et al., 1992).

No new neurons are formed after birth. Infants are born with all the neurons and dendrites they will ever have. The human brain uses these neurons and dendrites to develop over a period of time and continues to develop until adolescence. The brain is programmed to produce and connect synapses across these neurons and dendrites to store new information as it is stimulated by experiences from the environment (Huttenlocher & Dabholkar, 1997). Development in the brain begins within the first month of conception and by six months of the gestational age, most neurons of the mature brain exist. Formed neurons move to specific areas of the brain where they serve a designated purpose. A process of pruning eliminates unnecessary and surplus connections. Experience plays a role in determining where pruning takes place. Excess neurons that form in infancy may be the reason for neural plasticity and the type of learning which occurs at this time (Huttenlocher, 1990). Connections that are used are retained and inactive ones pruned. Hence a lack of stimulation can result in a permanent loss of function. Connections made in the brain can increase or decrease by as much as 25%, depending on how much stimulation the child receives (Huttenlocher, Newcombe, & Vasilyeva, 1997). The communication that takes place in the developing brain between the neurons has been depicted in Figure 2.1.

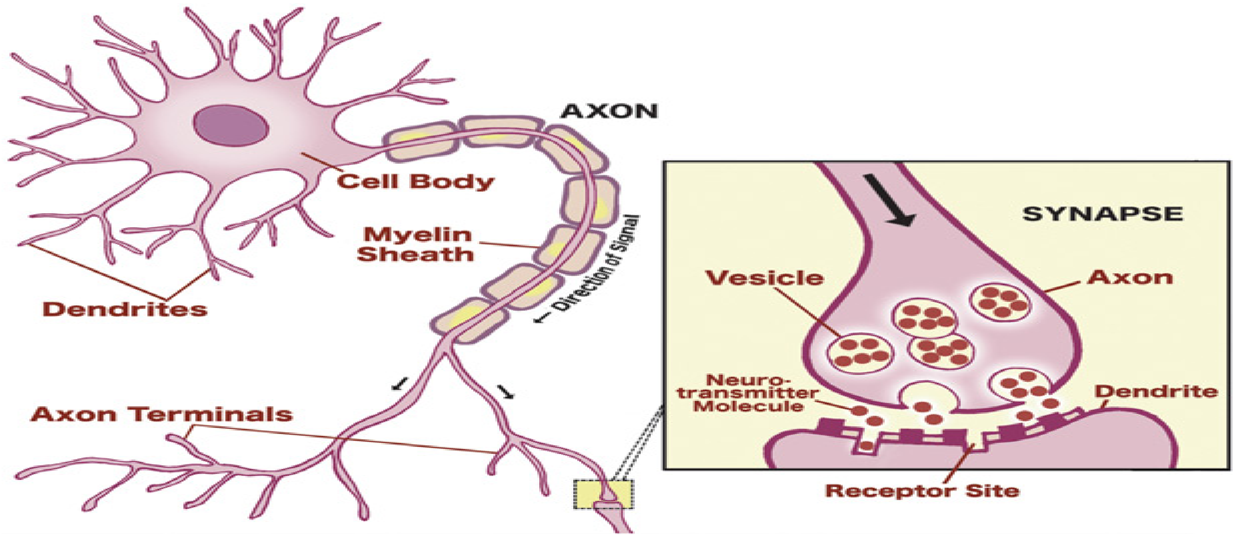

Figure 2.1: Communication between neurons
(source: http://www.urbanchildinstitute.org/why-0-3/baby-and-brain)

Two types of brain development can be described, namely experience-expectant and experience-dependent. Experience–expectant development relies on everyday experiences early in life that serve as facilitators for typical brain development. An example would be visual stimulation such as everyday sights assisting the development of vision. Experience-expectant development occurs throughout life. Individual experiences create opportunities for new growth and refine existing structures. Experience-dependent development depends on individual rather than typical everyday experiences (Thompson, 2001). The intervention programme that was used in this research study therefore relied on the parents (as this individual) to expose their infants to learning experiences that differ from everyday experiences.

The most intense development in the infant brain takes place in the sensory region (Thompson, 2001). During the development of the foetus and the first four months of an infant's life, there is a rapid extension of cortical size (Huttenlocher & Dabholkar, 1997). Development of the visual and auditory cortex peaks at about two to four months of age. The receptive language and speech production areas of brain development peak at about seven to ten months (Grantham-McGregor et al., 2007). In the visual cortex, structural changes and development correspond. Rapid brain growth and intensive motor and cognitive development show that the first two years of an infant's development are critical (Lima et al., 2004). The remarkable progression of the cerebellum in the first year explains the quick development of infant motor coordination and balance. The cerebellum is also involved in many cognitive functions. This extensive development of the cerebellum in the first year indicates that this growth is needed for later cognitive development. The brain therefore develops rapidly in the first year and more slowly in the second year (Knickmeyer et al., 2008).

Although the different areas of development are usually studied individually, they are not independent. Motor development and cognitive development have been found to be linked. For example, children with reading problems often also have developmental coordination disorders. Children under the age of two with speech and language problems normally have delays in achieving their motor coordination milestones (Viholainen, Cantell, Lyytinen, & Lyytinen, 2002).

The first year of life is a critical period for brain growth. Figure 2.2 depicts how the synapses of the neurons develop over time. Interference of brain development can have extended effects on the structure of the brain and its function (Shonkoff & Phillips, 2000). The first year presents a period of high vulnerability to negative influences, but also great openings for unlocking potential success with the assistance of intervention programmes (Allen & Duncan Smith, 2008). The researcher in this study therefore opted to focus on infants during their first year of life when the connections are forming a foundation for future development and learning.

Figure 2.2: Synapse density over time (*source*: Corel, 1975)

The first few years of life are critical for the emergence of skills that will provide future success at school level, including language, mathematics, reading skills and self-control skills (Allen & Duncan Smith, 2008). The intervention programme thus includes language interaction, introduction of number symbols and basic mathematics concepts and encourages visual stimulation.

Motor development is the process through which a child obtains certain movement patterns and abilities. The acquisition of these skills occurs in the context of the physical and social environment in which the child is raised. Environmental experiences interact with growth and maturation to influence motor development. Motor behaviour involves all movements of the body (including movements of the eyes and the infant's development of head control). Gross motor skills are movements that relate to the arms and legs or the whole body (such as walking), whereas fine motor skills include the use of fingers to grasp and manipulate objects. Motor skills such as reaching, touching and grasping are forms of exploratory activity (Adolph, 1997).

Motor development has been found to be linked to cognitive development. Piaget reasoned that cognitive and motor developments could not be seen as separate entities, because cognitive development relies completely on motor functioning (Piaget & Inhelder, 1966). Neurobiological evidence indicates a relationship between motor and cognitive development that continues into adulthood (Diamond, 2000). This study therefore considered both the motor and cognitive development of infants in their first year of life, although the primary focus was on cognitive development.

Cognitive development is the intellectual growth that starts at birth and continues to develop and grow into adulthood. This intellectual growth can be regarded as the learning process that begins from the moment an infant is born. Learning takes place through the interaction of people and objects. Infants use all their senses (seeing, hearing, feeling, tasting and smelling) to continuously absorb information. This cognitive development occurs in all the systems of the brain and focuses on the way learning takes place (Gleitman, 1981).

2.1.1 Developmental theorists

Developmental psychology focuses on the development that occurs from birth to adulthood. Areas of focus in developmental psychology vary from abnormal behaviour in children to typical child development as well as the factors that influence this development. Examples of developmental theories and theorists are as follows: psychoanalytic theories (Sigmund Freud and Erik Erikson), cognitive theories (Jean Piaget), behavioural theories (John Watson, Ivan Pavlov and Burrhus Skinner) and social child development theories (Lev Vygotsky, Albert Bandura and John Bowlby). Piaget, Vygotsky and Erikson are discussed in this study. Piaget explains the process of cognitive development during the stage of infant development which was required for this study. Vygotsky and Erikson both emphasise the role of caregivers. Vygotsky focuses on the importance of intervention and Erikson on the nature of social relationships.

2.1.1.1 Piaget's cognitive developmental theory

Jean Piaget was interested in the process of cognitive development. He studied how people adapt to the environment in which they find themselves and defined this behaviour as intelligence. The way in which the individual adapts and behaves in his or her environment, according to Piaget's theory is, "controlled through mental organisations called schemas that the individual uses to represent the world and designate action" (Huitt & Hummel, 2003). These schemas refer to both the intellectual and physical activities involved in forming categories of knowledge. These categories of knowledge help individuals to interpret and understand the world (Huitt & Hummel, 2003). New experiences create new information, which, in turn, can be used to adapt previously existing schemas. The process of taking new information into existing schemas is called assimilation. It is a subjective experience as it fits into previous beliefs or schemas. Assimilation allows individuals to alter existing information based on the new information in a process known as accommodation where new schemas are formed. Piaget believed that all children try to maintain a balance between assimilation and accommodation, which is achieved through a mechanism that Piaget referred to as equilibration (Huitt & Hummel, 2003). Owing to the fact that children are constantly in a process of development, it is important for them to maintain a balance between assimilation and accommodation as they progress through the stages of cognitive development.

Piaget divides cognitive development into four different stages. The sensorimotor intelligence stage (0 to 2 years), the period of representational thought which includes language development (2 to 6 years), the concrete operations stage (6 to 11 years) and the formal operations stage, which starts at age 11 (Campbell, 2006). For the purpose of this study, only the sensorimotor stage is discussed, because this is the stage relevant to the ages of the infants who were assessed. The sensorimotor stage focuses on the infant trying to make sense of the world through his or her sensory perceptions and motor activities. Sensory stimuli cause motor responses that are observed through the infant's behaviour. The infants use their abilities of looking, sucking, grasping, and listening to learn more about their environment.

Piaget believed that the development of object permanence is one of the most important aspects of the sensorimotor stage. Object permanence refers to the infant's ability to understand that objects continue to exist even though he or she can no longer seen or hear them. The sensorimotor stage can be divided into six sub stages (see Table 2.1 below).

Table 2.1: Sub stages of sensorimotor development

Age in months	Sub stage of sensorimotor development
0 to 1 month	**Reflexes** The infant understands the environment purely through inborn reflexes (e.g. sucking and looking).
1 to 4 months	**Primary circular reactions** The infant coordinates sensations and creates new schemas (e.g. the infant may suck his or her thumb by accident and then later intentionally repeat the action).
4 to 8 months	**Secondary circular reactions** The infant begins to focus more on the world and begins to repeat an action intentionally in order to trigger a response in the environment (e.g. the infant will purposefully pick up a toy in order to put it in his or her mouth).
8 to 12	**Coordination of reactions**

months	The infant starts to show clear intentional actions by exploring the environment around him or her and imitate the observed behaviour of other people. The understanding of objects also begins during this time and children begin to recognise certain objects as having specific qualities (e.g. a child might realise that a rattle will make a sound when shaken).
12 to 18 months	**Tertiary circular reactions** Infants begin a period of trial-and-error experimentation during this sub stage (e.g. the infant may try out different sounds or actions as a way of getting the attention of a caregiver).
18 to 24 months	**Early representational thought** Infants begin to develop symbols to represent events or objects in the world. They begin to move towards understanding the world through cognition instead of purely through actions.

Source: Adapted from Ginsburg & Opper (1988); Labinowicz (1980)

Piaget's theory and the development of cognitive systems focus on changes in the significance of a specific function and how the mind adapts to the environment (Papalia et al., 2009). The knowledge that infants gain from activities caused by reflex actions is later based on experience.

2.1.1.2 Lev Vygotsky's cognitive theory

Through his research, Vygotsky concluded that parents, caregivers, peers and the culture at large are responsible for the development of higher-order functions. Vygotsky's sociocultural theory highlights the fact that children live in different social and cultural contexts which affect the way their cognitive world is structured

(Bodrova & Leong, 2007; Rogoff, 2003). The cognitive development of mental functions was deemed to be social in origin. However, in making this claim, Vygotsky was confronted with the difficulty of reconciling this theory with the existing fact that newborn infants already possess certain mental functions. Vygotsky's answer to the problem was the introduction of an important distinction between lower mental functions and higher mental functions (Vygotsky, 1978). The relationships between these two functions are guidelines in understanding cognitive development. The lower mental functions can be seen as a prerequisite for the development of the higher mental functions. For example, the unmediated memory can be developed into voluntary attention and logical memory. The formation of the concepts, voluntary attention and logical memory, are based on Vygotsky’s theory that all functions in development appear twice, first, at a social level and later at an individual level (Vygotsky, 1978). Complex mental activities, such as voluntary attention, deliberate memory, categorisation and problem solving, have their roots in social interaction. Joint activities with more mature members of society provide a platform for children to master developmental activities.

Vygotsky developed a concept known as the zone of proximal development, which can be explained as the “distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 86). A child therefore may not have the ability yet to accomplish a certain task or the understanding to apply the knowledge, but with proper assistance has the ability to learn. Hence development follows the child’s ability to learn in Vygotsky’s theory and think in ways that have meaning in his or her culture. Vygotsky’s theory has been applied mostly to preschool and school age children, who are more advanced in their language and social skills development. In recent years, this theory has been extended to infants and toddlers. Infants are equipped with capabilities that ensure that caregivers will interact with them. Adults adjust their environment and the way they communicate accordingly so that learning is encouraged in these social circumstances.

2.1.1.3 Erik Erikson's social cognitive theory

Erikson emphasised change throughout life. He saw development as a social phenomenon, which reflected a desire to affiliate with people. Erikson's theory has eight stages of development that unfold throughout life. The first stage is trust versus mistrust (0 to 1 years); the second autonomy versus shame (1 to 2 years); the third initiative versus guilt (2 to 6 years); the fourth competence versus inferiority (6 to 12 years); the fifth identity versus role confusion (12 to 18 years); the sixth intimacy versus isolation (19 to 40 years), the seventh generativity versus stagnation (40 to 65 years); and the eighth integrity versus despair (65 years to death). Each stage consists of a distinctive developmental task that challenges individuals with a crisis. The crisis is not regarded as a disaster, but rather a turning point of increased vulnerability and improved potential. The more successfully an individual resolves the crises, the healthier development will be (Hopkins, 2000).

The first two stages of Erikson's eight stages of development are applicable to the age of the participants in this study. Erikson believed that patterns of trust or mistrust form in the first few years of life. A sense of trust desires a feeling of physical comfort with little fear and anxiety about the future. Trust in infancy sets the platform for a lifelong expectation that the world will be a good and pleasant place. These patterns of trust or mistrust can influence a person's actions and interactions for the rest of his or her life (Erikson, 1950). This theory was based on the response a parent or caregiver would give to an infant's primary needs. A lack of response or inadequate response will develop basic mistrust resulting in depression or withdrawal later in life (Boeree, 2006). Secure attachments form when a parent responds quickly to an infant's cries. These quick responses can have benefits beyond the first few years of life. Infants with secure attachments have proven to be more settled and confident in their relations with adults and peers than children who have not formed secure attachments (Shonkoff & Phillips, 2000). Securely attached young children not only have social benefits, but are also more balanced, have better language and cognitive, and problem-solving skills. They show a greater conscience development than insecurely attached children (Sroufe, 1998).

The second stage of Erikson's developmental stages is autonomy or shame and doubt. This stage occurs in late infancy and toddlerhood (1 to 3 years). Once the feeling of trust has been gained, infants start to realise that their behaviour is their own. They start to assert their sense of independence. The problem is that if the caregiver addresses this stage with too much restraint or punishes the infant too harshly, then the infant is more likely to develop a sense of shame and self-doubt. The social-emotional processes of development in the different life stages of person are a key factor in Erikson's social cognitive theory.

2.1.2 Factors that affect child development

Infants develop at a rapid rate in their first year of life. These changes and developmental achievements are accredited to an inherent growing-up process. It is important to acknowledge the fact that these developments rely not only on internal factors, but also on the environment and experience (Thompson, 2001). Individual child characteristics such as age, gender, race, genetics and health can all have an impact on child development (Kelley, 2006). External factors that have an impact on the development of an infant in the first year of life are his or her physical and social environment. Poverty, health, nutrition and social problems are included in these factors and limit children's potential in developing countries (Grantham-McGregor et al., 2007).

2.1.2.1 Prematurity

Premature birth is defined as a birth that occurs before the 37th week of pregnancy (Kelley, 2006). Prematurity is linked to infants that experience either short or long-term developmental problems. Premature infants can experience neurodevelopmental and socio-emotional deficits. These deficits include cognitive delays, speech and language disorders, neuron motor problems and perceptual problems (Bennett, 1988). Problems not detected early in premature children often become apparent in the classroom environment where developmental and behavioural challenges become increasingly apparent. Usually problems identified at this stage do not lessen, but may continue into adolescence and even young adulthood (Rickards, Kelly, Doyle, Lex, & Callanan, 2001).

Assessment of premature infants can therefore play a vital role in the prevention or management of problems later in life. Assessment in premature infants requires the age of the infant to be adjusted. This adjustment in age can take place up until the age of two years**,** and at this stage the infant should have caught up with his or her peers (Faure & Richardson, 2002). Premature age can be corrected by taking the infant's chronological age minus the amount of time he or she was premature. The age of premature infants in this research study was corrected using this method as required by the BSID (III) assessment.

2.1.2.2 Illness

Infants who suffer from constant ill health in their early years can experience developmental delays. Chronic illness would require the infant to be hospitalised more regularly. This creates limitations on participation in normal everyday activities and can therefore affect social skills, because sick infants are often more irritable and not as responsive to their surroundings. Illness can indirectly affect the infant's development, as parents tend to be more protective. "Restrictive, controlling caregiver behaviour has been associated with poor cognitive development and social skills later on in children" (Zelkowitz, 2006, p. 3).

2.1.2.3 Gender

Gender differences are already evident in an unborn infant's brain (Biddulph, 2008). The brain in a male infant develops more slowly than the female infant brain and is about 10 to 15% heavier. The connections between the left and right side of the brain are not as well connected in the male brain as the female brain. The left half of the cortex grows more slowly than the right in any infant. However, the testosterone in a male's blood stream slows the growth down even more. Because the left side of the male infant brain is not ready to make all the connections, nerve cells reaching from the right side of the brain connect more to the right side of the brain than to the left. Connections in the male's right brain are therefore a lot richer than those in the female. The male brain does not connect as well as the female brain between the two hemispheres (left and right side of brain). The way these connections take place between the two hemispheres of the male brain explains the reason for a male's aptitude for greater spatial awareness and ability to do better at mathematics than a female (Biddulph, 2008; Stoppard, 2008). Linn and Petersen (1985) indicate that at the age of four, girls outperform boys slightly on spatial ability, but starting from the age of five, boys obtain better scores than girls, and the difference becomes statistically significant at the age of 11. A study by Levine, Huttenlocher, Taylor, and Langrock (1999) confirms this, because it reveals a significant male advantage after four-and-a-half years of age.

The earlier development of the left side of the brain (cortex) in females controls thinking and therefore gives girls better language and memory-related skills (Stoppard, 2008). The stronger connections between the left and right side of the cortex in the female brain gives girls an advantage in message transmission. Girls will therefore show separation anxiety earlier than boys. Girls demonstrate better reading skills, because of the stronger connections between the left and right side of the cortex (Stoppard, 2008).

There are also differences in the social behaviour of boys and girls. The female infant tends to develop social skills much faster and earlier than the male infant.

Girls are generally more sociable than boys. Girls form closer friendships at an earlier age, are more compliant when asked to do something, are less socially aggressive and have a tendency to cope better with emotional and intellectual stress (Stoppard, 2008). Boys are more socially aggressive and dominant than girls. They tend to have short-lived friendships, because they are more interested in objects than in people. Boys are emotionally more vulnerable than girls (Stoppard, 2008).

Females are at an advantage to males when it comes to early language acquisition, but these differences disappear as they grow older. Stuttering, autism and dyslexia are more common in males (Wallentin, 2008). A study of children between the ages of 40 and 70 months by Haden, Haine, and Fivush (1997) revealed that girls formed longer and more structured descriptions than boys of the same age. The study showed no differences in the way parents spoke to either their sons or daughters. The results concluded that girls are more advanced in their narrative production than boys, and that socialisation does not satisfactorily account for these differences. Similar results were found in a behaviour genetics study in which more than 3 000 pairs of two-year-old twins participated (Galsworthy, Dionne, Dale, & Plomin, 2000). The gender differences found in this study showed that the girls did better in language acquisition than the boys.
Differences in motor development between genders appear to be unpredictable. Two different observations have been made. One observation indicates that boys have a tendency to be more delayed than girls, while other observations indicate that there are no differences in motor development between the two sexes (Lima et al., 2004).

The Multicentre Growth Reference Study measured the influence of gender on motor development, and six motor development milestones were observed longitudinally. The ages of the infants were between four and 24 months. No significant difference was observed between the sexes of the same age (WHO MGRS, 2006, pp. 66-75). The World Health Organisation supports international gross motor standards for both genders despite the above observation (WHO MGRS, 2006, pp. 66-75). Hence, differences in gender may need to be measured when assessing infants.

Gender differences in development do exist (Galsworthy et al., 2000), and based on the above information, girls tend to do better than boys in cognitive, language and (possibly) motor skills. This could have implications for assessing different genders at the same chronological age.

2.1.2.4 Ethnicity

A set of beliefs, values, goals, attitudes and activities that directs the way a group of people live can be defined as culture (Payne & Taylor, 2002). Culture is shaped by factors such as demographics, religion and the political and economic situation of the group, as well as access to educational and health-care systems. The way parents raise their children is essentially determined by these cultural and ethnic factors.

Mayson, Backman, Harris, and Hayes (2009) and Kaufman and Cooper (2001) suggest that the term “ethnicity” should include both race and culture. Ethnicity therefore includes two factors, cultural influences and beliefs (rearing practices and parent expectations) and racial influences (biological and genetic influences). An understanding of ethnicity and the two factors that influence ethnicity is important for screening, assessment and intervention purposes. If the literature suggests that infants from different race or populations groups demonstrate different rates or patterns of skill acquisitions, then assessments should accurately make this comparison to the appropriate normative standard. This is especially important if certain race groups should obtain certain developmental skills at a later age than the prevalent Western normative standard. Knowledge of ethnic influences on development is therefore an essential guide for paediatric therapists to manage infants with developmental delay in a culturally sensitive manner (Abbott & Bartlett, 1999; Mayson et al., 2007).

A Millennium Cohort Study that was conducted in the United Kingdom investigated infants of different ethnic backgrounds. The aim of the study was to determine whether the milestone achievements of these nine-month-old infants would differ. The sample was made up of the following ethnic groups: European, Indian, Pakistani, Bangladeshi, black Caribbean and black African. The study indicated that ethnic differences do have an impact on development (Kelley, 2006). Ethnic differences were found to affect the achievement of gross motor development. Black Caribbean and black African infants attained better gross motor skills at nine months than the white infants (Kelley, 2006). Developmental differences were explained on the basis of social and economic factors as well as biological factors (Kelley, 2006).These factors encompass the term “ethnicity” as defined previously.
Ethnic influences in child development are not always easy to identify. A mixture of nature and nurture is required for development. The biological make-up of an infant can also influence development (Fernald, Kariger, Engle, & Raikes, 2009). Language disorders in particular have a genetic basis (Galsworthy et al., 2000; Viholainen et al., 2002), and assessments are not always normed to allow for accurate comparisons between different cultures and races.

In South Africa, with its diverse ethnicity, it is vital to take into account the influence it can have on the assessment of infants.

2.1.2.5 Social and environmental factors

Social and environmental factors such as poor infant nutrition, stressful life events, poor mother and child interactions, absent fathers and exposure to environmental risks can all have an impact on an infant’s development. A combination of factors affect an infant’s development, and a specific factor cannot be singled out (Breitmayer & Ramey, 1986; Rutter, 1979; Sameroff, Seifer, Baldwin, & Baldwin, 1993).The environmental factors that children in South Africa are exposed to play a role in increasing developmental risks over time. The cumulative effects of exposure to risk factors on development in infants become more obvious as they grow older. Previous studies indicate that higher cumulative levels of risk are linked to poorer cognitive development (Brooks-Gunn, 1996), psychological distress, behaviour problems (Brooks-Gunn, 1997) and communicative development (Hooper, Burchinal, Roberts, Zeisel, & Neebe, 1998). Interventions that are integrated and simultaneously address risks such as education, nutrition and stimulation in the development of infants, are more effective in preventing developmental decline than singular interventions in the developing world (Engle et al., 2007). However, since it is not always possible to address all the risks, interventions need to focus on activities that will have the greatest impact.

Intervention programmes should focus on the different risks that are present; the percentage of children affected; the severity of the risks; and research on the age at which children are most likely to benefit from interventions. Evaluations of programmes and interventions must measure all existing risks and consider analytical strategies that will be most effective at demonstrating the desired impact.

Healthy development is dependent on the quality of the children's environment. Environmental and social risks are present throughout an infant's life and other risk factors may emerge and accumulate over time.

2.1.3 Early stimulation and infant learning

A report on a Berkeley Growth Study (Bayley & Schaefer, 1964) on the mental and physical development of individuals shows that the variability in individual scores can differ, especially during the first three years of life. The study does, however, indicate consistent patterns that link behaviour during the first three years of life with cognitive performance at 18 and 36 years of age. The study also shows that the cognitive development in adults who were actively stimulated in the first three years of their life was much better than adults who did not receive as much stimulation or attention in those formative years. Research shows that the way parents communicate and stimulate their children in the first years of life are linked to later school performance. Infants who are not exposed to stimulating environments miss out on important developmental opportunities (Hart & Risley, 1995).

In a research study by Cooper and Aslin (1994), it was found that at two days old, an infant can recognise his or her mother's voice and prefers it over any other sound (Cooper & Aslin, 1994). At three months old, a baby can tell the difference between colours and has a preference for blue and purple over red, yellow and green. Infants' visual abilities develop in such a way that at just three months of age they can perceive colours in a way that is comparable with adults (Zemach, Chang, & Teller, 2007). At seven months old, an infant can match vocal expressions with facial expressions, and at nine months old, a baby can imitate simple actions on objects (Meltzoff, 1988). This means that cognition in infants starts developing at an early age.

Research furthermore shows that infants have the ability for long-term memory of sound patterns. In a study by Jusczyk and Hohne (1997), stories were played to infants where a number of the same words were used regularly. Two weeks later, the infants' memory for these frequently repeated words were tested. Infants showed a preference for listening to the familiar words rather than a set of similar foil words. The infants were eight months old, signifying that by the end of the first year, infants have a significant vocabulary of word forms based on their exposure to language (Swingley, 2005). Infants have an unconscious memory for detailed sound patterns, and even though they might not comprehend what they are hearing, their brains are paying attention and learning (Jusczyk & Hohne, 1997).

In the first year of life, infants are sensitive to numerical and related spatial representations (Wynn, 1992). These primary abilities appear without much input or instruction (Berch, 2005). Preverbal number knowledge is shared by small children regardless of culture and cognitive abilities (Gordan, 2004). This can lay the foundation for acquiring symbolic number sense which is secondary. Children start counting as soon as they can talk. Studies have shown that children with difficulties in mathematics have a weak foundation in their early learning of number concepts as opposed to specific cognitive deficits (Landerl, Bevan, & Butterworth, 2004). “If children leave kindergarten with weak number competencies, especially with respect to operational knowledge and skills, they may never catch up to children who started with better number competencies” (Jordan & Levine, 2009, p. 63). Number sense can be reliably measured in young children and is predictive of later mathematics achievement outcomes (Clarke & Shinn, 2004).

In South Africa, the government has developed a curriculum for children from Reception to Grade 12; this curriculum aims at educating the children of South Africa in schools around the country. According to international research, South African learners do not compare favourably with learners in other countries in the area of numeracy development (Heugh, 2001). Research studies have shown that black South African learners are not prepared for formal education (Pretorius & Naude, 2000). This means that there needs to be more focus on foundational learning for important number and language skills. In South Africa, the performance of learners in literacy and numeracy is alarmingly poor (Motshekga, 2010). A research study by Girolametto, Weitzman, Lefebvre, and Greenberg (2007) showed that many teachers in care centres in the USA lack the knowledge to facilitate the development of literacy skills. These findings could apply to the South African context since formal qualifications for teachers of Grade R learners were not a prerequisite until 2011 (Motshekga, 2010). The need for teacher support in the implementation of the curriculum in the early years has become a national priority (Department of Education, 2008; Motshekga, 2010).

Kumon Maths and Kip Mcgrath are two examples of educational programmes offered in South Africa, which focus on numerical literacy. These programmes are aimed at children from three years and up. At this stage, there are no similar numeracy programmes aimed at infants to provide optimum benefit in terms of number concepts, shapes and colours for those crucial first months of life when the brain is busy developing and synapses are being pruned. The programmes are also costly and therefore not available to children in the poorer socioeconomic sector. The Baby Einstein brand offers stimulating DVDs, books and CDs that teach a range of various concepts including shapes and colours. Using DVDs for educational stimulation removes the personal interaction between mother and infant. According to Zimmerman, Christakis, and Meltzoff (2007), the time spent in front of a television screen does not promote infant development; in fact, many paediatricians discourage screen time for children under the age of two (Zimmerman et al., 2007). However, research examining the specific effects of infant DVDs is limited. In a 2006 study, children between the ages of eight and 16 months who were exposed to baby DVDs scored lower on a language development test than the babies who had no screen time (Zimmerman et al., 2007). A 2009 study of children between the ages of two months and four years showed that turning on the television reduced verbal interaction between parents and children. This reduced verbal interaction could be the cause of delays in language development (Christakis et al., 2009). In addition, a 2010 study found no proof that children between the ages of one and two learnt words highlighted in a Baby Einstein DVD (Richert, Robb, Fender, & Wartella, 2010). In contrast, research has shown that regularly reading to young children boosts the language ability of both babies and toddlers (Richert et al., 2010).

Findings of research studies show that there is evidence of the fact that children's early cognitive development is linked not only to specific stimulation, but also to family environmental factors such as language stimulation, the responsiveness of parents, the emotional support given by parents, the number of stimulating toys and objects available, how the home is organised, safety and other external experiences (Bradley & Caldwell, 1976). This can therefore indicate that proper implementation of an educational programme for infants not only develops their ability for cognition, but also promotes their ability to open doors to address other problems experienced by children in South Africa.

An investigation of the effects of introducing an intervention programme at such an early age can be done by applying a standardised assessment measure. Assessment of children can be challenging, because many factors need to be taken into account during the process (Black & Matula, 2000). Each infant or child needs to be closely examined for cultural and social differences. Culture is important, because different cultures view concepts such as intelligence differently. For example, Western cultures place more emphasis on intelligence, whereas rural African cultures see intelligence as an ability to perform skills that are necessary for family life and growth (Grieve, 1992). In the assessment process of this study, it was essential to ensure that the programme was properly implemented taking cultural differences into consideration so that the cognitive abilities of the infants could be assessed as fairly as possible.

2.2 ASSESSMENT MEASURES FOR INFANTS

The assessment of infants can be complicated, because numerous factors need to be taken into consideration in assessing young children. This means that the correct assessment measurement or tool needs to be selected for any assessment diagnosis or research study to be considered reliable and valid. Developmental screening and diagnostic testing are used to assess the development of infants and small children.

Screening tools are simple to administer, involve parental input and correlate well with direct assessments. They are cost effective and efficient. The negative aspect of a screening tool is that teachers or caregivers may inflate scores, interpret items differently according to cultural differences and report a child’s abilities inaccurately. Although screening tools cannot be used for the purpose of diagnosis, they help to determine whether further assessment is required.

Screening tools usually involve parent questionnaires, and a few examples would be the Ages and Stages Questionnaire (ASQ), the Paediatric Evaluation of Developmental Status (PEDS), the Minnesota Child Development Inventory (MCDI) and the Kent Inventory of Developmental Skills (KIDS) (Johnson & Marlow, 2006). Trained professionals can use the Denver II screening test, the Bayley Neuro Developmental Screener and the Batelle Developmental Inventory. These screening tools are more complex and require more time and effort to administer and interpret (Kerstjens, Bos, Ten Vergert, De Meer, Butcher, & Reijneveld, 2009).

In South Africa, a developmental screener was developed as a home-based assessment and intervention programme for developmentally delayed children from birth to seven years of age. The Strive Toward Achieving Results Together (START) developmental screener assesses all areas of development. It is currently available in English and Zulu (HSRC, 2010). Research on this developmental screener could be useful too because it has been developed for the South African population, but would require standardisation.

Diagnostic measures that have been standardised are the most suitable tools for recognising and monitoring problems in development. These diagnostic measures allow for the collection of information directly and minimise recall bias, and they offer high quality data, but require extensive training. Accuracy is dependent on the quality of the test as well as its appropriateness for certain populations (Fernald et al., 2009).

The individual assessment of the infant’s development is compared to the norm (Johnson & Marlow, 2006). The norm refers to a group of children with similar characteristics and functioning. A trained examiner formally administers standardised tests. The examiner follows a strict format for administering and scoring the test, implying that the results can be interpreted objectively.

Standardisation of an assessment requires administering the test to a relatively large group that represents the population for whom the test was developed. This group is known as the normative sample. Individual scores can be compared to these norms to reflect how the child is developing or functioning in comparison with the average group. These scores are called norm-referenced or normalised standard scores. They follow a normal distribution with a mean and standard deviation (SD) and are age specific. In the case of cognitive tests, the mean is typically 100 and the SD 15. The developmental level of the infant or child is usually measured (and described) by how much the specific child's individual score deviates from the normative sample (Johnson & Marlow, 2006).

The appropriateness of the test is not always ensured by the fact that it is standardised, but it does indicate that conclusions that are more accurate can be drawn on the development of a child being assessed. How recently an assessment has been standardised is of vital importance. The Flynn effect occurs when the mean score increases over time in a standardised test (Teasdale & Owen, 2005). This is a common problem with standardised tools and the interpretation of children's development if the norms are old.

Standardised tools can be expensive and can only be applied by people with suitable qualifications or sufficient experience (Johnson & Marlow, 2006). The main problem with an assessment that is standardised occurs when these assessments are used on populations that are different from the norming sample (Johnson & Marlow, 2006). The disadvantages of standardised assessments are that the assessments become outdated owing to changes in populations. They are expensive and can be time consuming. The advantages of standardised assessments are that they can be used for a large group, they allow for accurate follow up assessments and different assessors can be used and still achieve the same outcome. The standardised assessment scores can be compared to norms, and this allows for accurate identification diagnoses in the social, physical, emotional, intellectual and creative developmental domains.

Diagnostic measures developed for general use in South Africa include the Senior South African Individual Scale – Revised (SSAIS – R) and the Junior South African Individual Scales (JSAIS). The New South African Individual Scale was first published in 1964, and later renamed the Senior South African Individual Scale

(SSAIS). This diagnostic measure was the first standardised measure for preschool children (5-year-olds) (Huysamen, 1983). The sample was not an accurate representation of the relevant population and therefore only provisional norms were provided (Madge, 1983). A review of the SSAIS led to the instrument being renamed the Senior South African Individual Scale – Revised (SSAIS-R) in 1991 (Van Eeden, 1991). The target age group of this instrument is children between the ages of seven and 16 (Van Eeden, 1991). The Junior South African Individual Scales (JSAIS) was developed and standardised for the three to seven age group (Madge, 1981). For the purpose of this study, an assessment was required that would assess the infants in their first year of life. Although the above-mentioned assessments have been standardised for South Africa, they all focus on the preschool age group and thus exclude infants.

Selection of an assessment measure that is appropriate requires the consideration of factors such as reliability and validity, qualifications of the assessor as well as the purpose of the testing (Tieman, Palisano, & Sutclive, 2005). The appropriate assessment measure is not always available in developing countries and can be expensive. South Africa needs a suitable tool to assess all areas of child development. In the next section, the suitability of a number of measures is considered for the present study.

2.2.1 Diagnostic measures for the assessment of infants

The Griffiths Mental Scales (Griffiths), the Bayley Scales of Infant Development (BSID), the Batelle Inventory (Batelle), the Developmental Assessment of Young Children (DAYC), and the Denver Developmental Screening Test (Denver) are all examples of standardised assessments for child development.

The Griffiths Scales assess locomotor, personal social, hearing and language, eye hand coordination and performance domains. The age range is birth to 23 months and it takes 30 to 60 minutes to administer the test. The Griffiths can be used by trained professionals and was standardised in 1996 (Johnson & Marlow, 2006). In a comparative South African study using the Griffiths Scales, the performance of nine-month-old South African infants was compared to that of British infants (Von Wielligh, 2012). The South African sample was selected according to availability and included Indian, coloured, white and black infants. Gender ratio was approximately the same. The British sample was based on the standardisation sample. A difference in performance between the genders was observed. The nine-month-old baby girls attained a statistically significantly higher scores on the Locomotor Scale (Subscale A), Personal-Social Scale (Subscale B) and on the Language Scale (Subscale C). The main reason for girls obtaining higher scores on these scales than boys of the same age is based on the factor of different gender role expectations, by society and by the particular caregivers (Von Wielligh, 2012). In a cross-cultural study between South Africa and Britain, 129 South African and 169 British children between the ages of four and seven years were assessed. The findings revealed that the overall performance on the Griffiths Scales of the South African and British children in this age group was similar (Van Rooyen, 2005).

The BSID assesses cognitive, language and motor areas of development. The age range is one to 42 months, and the test takes approximately 30 to 90 minutes to administer. It was standardised in 2006 (Johnson & Marlow, 2006). The BSID (I) was used as an assessment tool in 1992 on black South African infants. The results of the study indicated that these South African infants scored higher than the US standardisation sample. The South African infants scored statistically higher on the motor scale from two to ten months and the cognitive scale from four to15 months (Richter et al., 1992). Between the ages of 18 and 30 months, no developmental differences were found between US infants and the black South African infants (Lynn, 1998).

In 2005, a similar research study was conducted using the BSID. The study sample consisted of 128 Nigerian children. Once again, it was determined that the Nigerian infants attained scores higher than the scores obtained by the US infants in the early months of the infants' life (Aina & Morakinjo, 2005).

The BSID was used in local studies that considered factors influencing developmental delay. A research study conducted at the Paediatric clinic at the Chris Hani Baragwanath Hospital in Johannesburg used the BSID (II) to assess 40 children between 18 and 30 months infected with human immunodeficiency virus (HIV). It was discovered that 85% of the sample had delays in gross motor development and more than 82% had delays in language development. The advancement of the disease explains delays in cognitive development as well as structural damage to the brain. Language delay can be attributed to neurological weakening in the brain and/or environmental deprivation (Baillieu & Potterton, 2008).

The role of developmental delays was also investigated in a study of 30 South African infants to determine if pre-term infants were at risk of experiencing developmental delays in relation to full-term infants. The BSID scores showed that there were significantly lower scores in both the Mental Developmental Index (MDI) and the Psychomotor Developmental Index (PDI). This proves that at 18 months, infants born prematurely have a greater possibility of suffering from developmental delay in comparison to full-term infants (Brown, 2009).

A Zimbabwean study used the BSID (III) to assess of 60 infants. Twenty-eight of them were infected with the human immunodeficiency virus (HIV) and 32 did not have the virus. Statistically significant differences were found in anthropometry and development between the HIV-infected infants and those who did not have the virus. The BSID (III) showed that the mean developmental delay for the HIV-infected group was two months for all scales of the BSID (III) (Hutchings & Potterton, 2013).

The BSID (III) was therefore selected for the current study for its comprehensive assessment of the cognitive, language and motor developmental areas as well as its validity and reliability. Although the multicultural South African population requires possible revision and updating of norms, reliability and validity, information is essential for this and other developmental tests (Richter et al., 1992). It was decided that the BSID (III) would be suitable in terms of the objective of the present study.

The Batelle Developmental Inventory (II) (Batelle II) is not as well-known as the Griffiths and BSID (II). The Batelle (II) assesses personal-social, adaptive motor, communication and cognitive areas. Its age range is birth to eight years, and it takes one to two hours to administer. It was standardised in 2003 (Johnson & Marlow 2006). An overseas study by Glascoe (2001) explored whether children who pass screening tests are different from children who fail such tests, and whether children are referred unnecessarily for diagnostic assessment and intervention planning. A sample of 571 children between the ages of eight months and seven years were assessed using the Batelle(II). Glascoe (2001) determined that children who were referred unnecessarily for diagnostic testing based on the results of developmental screens achieved considerably lower scores than children with true negative scores on measures of intelligence, language and educational success. These children had additional psychosocial risk factors such as limited parental education and minority status. This indicated that children who achieve false-positive results on screening tests actually also require the opportunity for diagnostic testing. This would be beneficial in helping direct the focus of intervention efforts such as programmes known to improve language and cognitive, and academic skills such as tutoring, private speech therapy, and quality day care.
The Developmental Assessment of Young Children (DAYC) is used to identify children from birth to five years who require early intervention. The assessment requires ten to 20 minutes to administer. This is a standardised test with norms, based on a large sample done in 1996. This assessment consists of the following five domains; cognition, social and emotional development, communication and

physical development (Western Psychological Services, 2009). A South African comparative study of the BSID and DAYC assessed deaf infants between the ages of one and five months. The study determined that the DAYC could serve as an appropriate substitute for the BSID when used with deaf infants (Clayton, 2008).

The Denver (II) assesses four areas, namely personal social, fine motor adaptive, language and gross motor. It can be used for children from birth to six years of age. The assessment was published in 1992 and standardised on a sample representative of the 1980 US census population. This assessment has been translated into several languages and has been standardised for 12 countries to create national norms (Frankenburg, Dodds, Archer, Shapiro, & Bresnick, 1992). The norms have been developed according to the Western norms and are therefore not valid for different cultures (Papalia et al., 2009).

2.2.2 Bayley Scales of Infant Development

The Bayley Scales of Infant Development is a commonly used standardised assessment tool for clinical and research purposes and is known as the gold standard of infant assessment (Gauthier, Bauer, Messinger, & Closius, 1999; Harris et al., 2005).

There are three editions of the Bayley Scales of Infant Development. The first edition was released in 1969, the second in 1993 and the third in 2006 (Harcourt Assessment, 2007). A number of changes were made from the second to the third edition of the BSID. The reasons for these changes are explained in the manual. The main aims of the changes were to meet legislative requirements and assessment needs and improve content coverage and the accuracy of administration and scoring and updating the norms on the BSID (III) (Bayley, 2006).

The BSID (III) measures cognitive, language (expressive and receptive), motor (gross and fine), social-emotional and adaptive behaviour (Harcourt Assessment, 2007). The Behaviour observation inventory comprises of the social-emotional and adaptive behaviour scales.

The BSID (III) is a psychometric assessment tool originally developed in the USA. The norms of this assessment tool correspond to the US population. The normative sample consisted of 1 700 typically developing children (born 36 to 42 weeks' gestation) aged from 16 days to 43 months 15 days (Bayley, 2006). Normal development in infants and toddlers was defined as children who do not have any significant medical complications at or after birth. These infants and toddlers also had no medical or behavioural diagnoses. The sample was stratified, on the basis of the information acquired from the October 2000 US census (Bayley, 2006). Stratification was based on demographic variables such as race, age, sex, parental level of education and geographic region. The races were included proportionally according to the census. The races included whites, African Americans, Hispanics, Asians and other minority groups (Bayley, 2006).

The standardisation process required the inclusion of clinical cases to ensure that the data was an accurate representation of the population. The clinical cases that were included made up approximately 10% of the sample. These infants and toddlers had been diagnosed with the following medical conditions: cerebral palsy, pervasive developmental disorder, Down's syndrome, prematurity, language impairment and those at risk for developmental delay (Bayley, 2006).

The BSID (III) measures the developmental ability of children between the ages of one and 42 months of age. The BSID (III) can also help to identify any delays or problems that may exist in the five major developmental domains (Bayley, 2006).

Reliability of an assessment tool refers to the accuracy and consistency of the measurement's ability to assess in a variety of different situations. The BSID (III) can be used to assess children with different developmental levels and clinical diagnoses. The technical manual contains data relating to internal consistency, standard error of measurement, test-retest reliability and inter-rater reliability. The BSID (III) has a high reliability (Bayley, 2006; Gauthier et al., 1999). Reliability coefficients for the subtests and the composite scores range from 0.86 to 0.93, with similar or higher coefficients obtained when examining test-retest reliability in a sample of 197 children. These children were assessed twice with an interval of six days between each assessment. The findings showed that the scoring and interpretive reliability coefficient was 0.67 to 0.94 with an average correlation of 0.80 (Reynolds & Fletcher-Janzen, 2007).

Validity refers to the availability of evidence to support the interpretation of the test scores for the purpose for which it was intended. Data is available on the content and construct validity of the BSID (III). Correlations between the subscales of the BSID (III) were found to be in the low to moderate range (Bayley, 2006), which indicates that there is evidence for construct validity. Construct validity was then established in a series of studies that proved that correlations within the subscales were statistically noteworthy. For example, cognitive items demonstrated higher correlations with the cognitive scale rather than the motor scale. Further support for the construct validity is found in the correlations between the BSID (III) and the BSID (II), Weschler Preschool and Primary Scale of Intelligence (3rd), Preschool Language Scale (4th), Peabody Developmental Motor Scales (2nd) and Adaptive Behaviour Assessment System (2nd) (Bayley, 2006). Comparisons between samples were also done in support of the construct validity of a measure. In this instance, the comparison between typically developing children and matched special groups indicated that the BSID (III) is able to pick up differences in infants and toddlers from special groups as well as the normative sample (Bayley, 2006, pp. 69-103).

The BSID (III) is the latest updated version. It is a well-known and widely used standardised tool and a comprehensive assessment that measures all developmental areas. Developmental differences exist and are normal, and care was thus taken when making comparisons of infants in the present study that were culturally or demographically different from the normative sample. Further revision and updating of norms in developmental tests is essential for validity on different populations (Richter et al., 1992).

2.3 INTERVENTION PROGRAMME: AUDITORY AND VISUAL PRESENTATION OF NUMBERS, SHAPES AND COLOURS

Many South Africa children are at risk. There is a huge need for intervention programmes to focus on the improvement of the development of vulnerable children (Van Rooyen, 2005). Intervention projects developed to improve development are usually most effective if combined with a nutritional and a psychosocial intervention strategy (Pelto, Dickin, & Engle, 1999). It is essential that the development and implementation of intervention programmes involve proper trial testing and monitoring to evaluate suitability and value. Assessment of outcomes for intervention programmes can be complex and are always affected by cultural context (Pelto et al., 1999).

The Numbers in Nappies intervention programme focuses on numbers, shapes and colours. The programme makes use of the unconscious memory in infants as mentioned in research by Jusczyk and Hohne (1997) to determine if the unconscious memory applies for number concepts. The infant's brain is stimulated by the programme at a stage in his or her life where the synapses are being connected through auditory and visual stimulation. The Numbers in Nappies programme has been designed to strengthen these synapse connections for numbers, shapes and colours. It is based on the work of right-brain educators, Glenn Doman and Mokoto Schichida, who through their work, discovered that infants can perceive numbers in a way that is not open to adults. Research by Schichida (1993) shows that between the ages of zero and three, the right brain, which is also known as the image brain, is dominant. This image brain allows immediate access to information stored in the memory (Schichida, 1993). The infant's right brain uses photographic memory to recall information from the flashcard as it was seen. The left brain is more logical and relies on repetition to absorb information (Schichida, 1993; Schichida 1997; Reynolds & Fletcher-Janzen, 2007). The flashcards in the Numbers in Nappies programme are based on the aforementioned brain science. The concepts of numbers, shapes and colours are taught in isolation and repetitively using a flashcard to stimulate the image brain at its optimum time.

The Numbers in Nappies programme avoids the use of technology, focusing instead on the importance of making learning a fun experience for both parent and infant (Doman & Doman, 2005).The programme promotes bonding between mother and baby, direct communication and affection, while the infant is exposed to the stimulation. The programme combines the methodology of both Doman and Doman and Schichida, but the daily sequence and number sentences are unique to the Numbers in Nappies programme. The Numbers in Nappies programme is easy to use and was developed with the idea of being economically and intellectually accessible to infants across all socioeconomic sectors.

The methodology of Doman and Doman (2005) and Schichida (1993) is based on showing simple flashcards with red dots to teach basic mathematic principles. These basic principles include teaching quantity recognition and equations using quantity, imaging and problem solving (Doman & Doman 2005; Schichida, 1993). Doman and Doman and Schichida differ slightly in the way mathematics concepts are introduced. Schichida's method requires a completion of teaching quantities before introducing equations, and blends all the operations (addition, subtraction, multiplication and division). Specific equations are set out and the brackets that enforce the order of operations are provided (Schichida, 1993). This was a slight adaptation of Doman and Doman's original method in an attempt to avoid any "serious errors" in the order of operations (Doman & Doman, 2005). Both methods require consistent daily flashcard exposure over a period of 65 to 90 days.

Research using neuroimaging in adults and young children shows that there are similarities in the posterior parietal region of the brain when it comes to representing numerical information. Numerical information can be presented symbolically or non-symbolically, visually or auditorily (Dehaene, Molko, Cohen, & Wilson, 2004). The Numbers in Nappies programme has been developed to represent the number concepts visually by means of the flashcard method and auditory, through the parent's voice. The programme allows the infant to be exposed to numbers, shapes and colours by making use of the most active part of the infant's brain during the three- to 12-month period. For this three- to 12-month age group, learning takes place through visual, auditory and sensory stimulation. A research study in the field of cognitive development by Halberda et al. (2008) investigated the relationship between infants' knowledge and later childhood knowledge. It was found that a relationship does exist and that scores are most reliable between six and nine months of age (Halberda et al., 2008). It therefore becomes imperative that an educational programme such as Numbers in Nappies is implemented and investigated during this optimal brain developmental time in an infant's life.

SUMMARY

Development in early childhood happens extremely rapidly and lays the foundation for later learning. Early assessment of infants can help to combat many of the factors that South African children face in their developing years. These factors such as the physical environment, individual characteristics and the social environmental can either limit or enhance the developing infant's potential.

At this stage, there are no standardised diagnostic assessments for assessing the development of infants in South Africa. In this chapter, various assessment measures were discussed, but it is essential to select an adequate measurement to ensure reliability and validity. Screening tools are cost and time efficient, but may not be sufficiently diagnostic. Standardised diagnostic developmental tools are expensive, but offer reliable reproducible results.

The Bayley (III) is a standardised tool that efficiently assesses all developmental areas, and although it was standardised in the USA it can be used in the South

African context. However, South Africa lacks suitable assessment measures to help the children of our country reach their maximum potential.

In the theoretical review of infant development, it is shown that development in children is rapid, complex and easily influenced in the first year of life. Assessment is critical during this time to ensure timely intervention, because it is during this period that infants benefit the most. Infants who receive positive and responsive care from their parents or guardians in the first years of their lives have a significant head start towards achieving success in their lives (Werner & Smith, 1992). This not only applies to emotional wellbeing, but also to learning opportunities.

CHAPTER 3

METHODOLOGY

This chapter focuses on the research methodology and how the methodology was employed in conducting the study. The research design, the participants, the sampling method, the assessment measures and the techniques of analysis are explained.

The study used the Numbers in Nappies programme as an intervention tool. The BSID (III) was used for quantitative assessment, and field notes from observation were used as well as parent feedback through a focus group for the qualitative data. The research question was answered and the objectives achieved by assessing 63 infants between the ages of three and 12 months.

3.1. RESEARCH QUESTION AND AIMS

This study explored the following research question: What is the effect of infant exposure to numbers, shapes and colours at an early stage of development?

An intervention programme was introduced to infants using numbers, shapes and colours. This programme lays an educational foundation through parent involvement. The objective of this study was to examine if early infant exposure to brain stimulation in the form of flashcards with numbers, shapes and colours increases the infant's cognitive processing potential.

3.1.1 Quantitative aims

The BSID (III) was used as an assessment measure to determine if there was a difference

(a) in the experimental group mean composite scores for each subscale (cognitive, language and motor development) before and after the intervention programme

(b) between the infants in the experimental group’s and control group’s mean composite scores for each subscale (cognitive, language and motor development) before and after the intervention programme

3.1.2 Qualitative aims

The qualitative aims of the study were as follows:

(c) To determine if there was a difference in the adaptive behaviour of the experimental group because of the added stimulation from their parents by means of the programme, before and after the intervention programme when compared to the control group

(d) To determine if there was a difference in the social emotional behaviour of the experimental group as a result of added stimulation from their parents by means of the programme before and after the intervention programme when compared to the control group

The qualitative aims helped to determine if there were any behavioural or social emotional changes stemming from parental involvement and the additional stimulation the intervention programme provided, through observation of the infants’ social and emotional behaviour. These observations were recorded in a structured format and explored in the focus group.

3.1.3 Research hypotheses

The research hypotheses for the above aims are indicated below.

3.1.3.1 Hypotheses for aim A

The null hypothesis (H0):

There is no difference in the mean composite scores for each subscale in the experimental group before and after the intervention programme.

The alternative hypothesis (H1):

There is a statistically significant difference in the mean composite scores for each subscale in the experimental group before and after the intervention programme.

3.1.3.2 Hypotheses for aim B

The null hypothesis (H0):

There is no difference between the experimental group's and the control group's mean composite scores for each subscale before the intervention programme.

The alternative hypothesis (H1):

There is a statistically significant difference between the experimental group's and the control group's mean composite scores for each subscale before the intervention programme.

The null hypothesis (H0):

There is no difference between the experimental group's and the control group's mean composite scores for each subscale after the intervention programme.

The alternative hypothesis (H1):

There is a statistically significant difference between the experimental group's and the control group's mean composite scores for each subscale after the intervention programme.

Age and gender have an impact on development. An investigation of these two factors helped to exclude them as possible alternatives for the conclusions based on the findings.

3.2 RESEARCH APPROACH

Quantitative research typically involves collecting and converting data into a numerical format. Statistical calculations are made and conclusions drawn. A researcher will have one or more hypotheses, which include predictions about possible relationships between the variables (Black, 1999). Statistical analyses allow researchers to discover complex causal relationships between variables to determine to what extent one variable influences another (Black, 1999).

Objectivity is imperative to quantitative research. The research study is considered, prepared and controlled in advance. The emphasis of quantitative research is on deductive reasoning, which tends to move from the general to the specific (Black, 1999). The validity of conclusions is shown to be dependent on the validity of one or more of the premises. Researchers rarely have access to all the members of a particular group and will make inferences from their study about these larger groups. It is imperative that the participants involved in the study are a representative sample of the wider population. Generalisations are limited to the number of people involved in the study, how they were selected and whether they are representative of the wider group (Black, 1999).

As mentioned earlier, the results reported are based on the *p*-value. A predetermined alpha, usually 0.05, is selected on the basis of the confidence interval selected by the researcher. The closer the *p*-value is to 0, the less likely it is that the observed difference will be due to chance. A result higher than the *p*-value indicates that there is no difference between the groups or variables (Black, 1999).

To achieve the qualitative aims of the study, a qualitative, exploratory and descriptive research approach was adopted (Gmeiner & Poggenpoel, 1996). In this way, data could be collected on the perceptions of the mothers concerning the effects of the intervention programme with specific focus on changes in the social and emotional behaviour of the infants.

Qualitative research has been criticised for being too generalised and having researcher bias. This type of research does have its advantages, which makes it more relevant for the initial components of a research study (McGiugan, 1990). The advantages are that a predetermined hypothesis is deliberately avoided and the researcher is thus able to identify outcomes not anticipated. The quality and depth of the data can therefore be used to their full potential (Geertz, 1973). Validity checks are included in qualitative research (Marshall & Rossman, 1989).The disadvantage is that qualitative research does not have statistically based checks, and this is a methodological weakness.

3.3 RESEARCH DESIGN AND METHOD

This study involved four phases. Phase 1 of the study was the preplanning stage. Phase 2 was a three-month qualitative study to prepare for phases 3 and 4 of the study. Phase 1 (the preplanning stage) and phase 2 (the qualitative stage) were completed, and the information collected was used to help develop the appropriate foundation for the research study. The first two phases of the study also helped the researcher to determine the sample size; lay the foundation for the intervention programme development; train the mothers; understand socioeconomic influences; and determine the most appropriate assessment to be used in the last two phases of the study (phases 3 and 4). Phases 3 and 4 were run simultaneously. Phase 3 required assessment for quantitative purposes and phase 4 included a focus group which gave feedback for the qualitative part of the study.

3.3.1 Phase 1

Phase 1 consisted of reading literature on numeracy in infants and young children, followed by discussions on the topic. The idea for the intervention programme was based on concepts in Doman and Doman’s (2005) book, *How to teach your baby math: the gentle revolution*. The mothers who read the book and followed the suggestions as explained in the book for teaching numbers were interviewed in an informal and general discussion. The discussions were based on their experiences of following the guidelines and their opinions of the benefits of introducing the number, shapes and colour concepts at such an early stage of the infant’s life. The information from the mothers, the background literature and other testimonials were then used to develop the programme for Numbers in Nappies. This programme differs from Doman and Doman’s guidelines. Although it uses the ”dot method” for teaching numbers (Doman & Doman 2005; Schichida, 1993), it includes shapes and colours in isolation and as combinations. The programme provides detailed instructions and a daily flashcard routine. The programme was edited and sent for printing. A pilot study (trial run) of the Numbers in Nappies programme was then done in phase 2 in order to obtain feedback and input.

3.3.2 Phase 2

Phase 2 of the study consisted of implementing the programme. Participants in the pilot study were first trained to use the programme. The training took place at the workplace of the mothers and fathers. The mothers and fathers were from two different socioeconomic economic classes. Three groups were used, each comprising ten mothers or fathers. Two of the groups were factory workers with low incomes, relying on public transport and living in informal settlements. All of them, however, had a Grade 12 education level. The third group of mothers or fathers was office staff from the middle-income sector, with their own transport and formal housing. All office staff participants had participated in further studies after Grade 12.

The training consisted of informal discussions between the researcher and participating parents. Video clips and role play were used to demonstrate and teach the correct method of using the intervention programme. The Numbers in Nappies programme was run over three months and started in June 2010 and was completed in September 2010. The groups met once every two weeks for feedback and additional training on the method, if required (the additional training was necessary for the lower-income groups). The feedback consisted of home video clips from parents taken on cell phones, recapping of the method in showing the infants the flashcards and a report of their experiences and suggestions from the parents. This information was used to edit the length of time infants spent on the programme, daily sessions were reduced from three to two and training was adapted to put a lot more emphasis on method (parents needed to be more encouraging, speak clearly and hold the flashcards in the correct positions).

3.3.3 Phase 3

Phase 3 of the study was quantitative. The infants were assessed by an occupational therapist using the BSID (III) assessment to determine the impact of the intervention programme. The BSID (III) is an assessment that can test infants from one to 42 months. The assessment is standardised and covers testing in cognitive, language and motor development, and it also includes a Behaviour Observation Inventory which is comprised of the social-emotional scale and the behaviour rating scale.

The BSID (III) presents the infants with situations and tasks intended to produce a noticeable set of behavioural responses. These observed responses are assessed directly on the three subscales of the BSID (III). The Cognitive Composite Scale consists of 91 items; the Language Composite Scale consists of 97 items and includes receptive and expressive language subtests; and the Motor Composite Scale consists of 138 items and includes fine and gross motor subtests. The infant’s parent or primary caregiver is also required to complete two additional scales, the Social-Emotional Scale and the Adaptive Behaviour Scale. The assessor completes a Behaviour Observation Inventory at the conclusion of the assessment to determine how often behaviours, such as positive affect and cooperativeness, are observed during testing. The assessor asks the child's caregiver to also rate the degree on this inventory to which the child typically exhibits the behaviour (Bayley, 2006).

The Cognitive, Language and Motor Scales each have an index score, with a mean of 100 and a standard deviation of 15. The cognitive, language and motor ages can be estimated from the norm tables provided with the assessment (Black & Matula, 2000). The BSID (III) was used to assess the impact of the Numbers in Nappies programme by specifically focusing on the cognitive scales. The Cognitive

Scale items that focus on mathematical concept formation, memory learning and problem solving were more closely analysed, but not exclusively. The Behaviour Rating Scale measured infant behaviour and the data was also used in conjunction with qualitative information from the focus group. Qualitatively, the implications of the increase and decrease of the means are explained in terms of their descriptive statistics.

The BSID (III) was developed in such a way that the parents can be present during the assessment. Participating parents were therefore present during assessment and could help to encourage responses from their infants. Assessment dates were arranged with the participating mothers. The assessor was a qualified occupational therapist with experience in the use of the BSID (III). The researcher was present at each assessment and assisted with the assessment process. A clinical psychologist supervised the assessment process to ensure that the administration and scoring were consistent, reliable and valid. Participants were required to complete a number of letters and questionnaires before commencement of the assessment. These are discussed in section on the collection of data.

Using the BSID (III), 63 infants (between 3 and 12 months) were tested. Each assessment took about an hour to complete. All 63 infants were assessed irrespective of whether they were part of the control or experimental group. A total of 34 infants participated in the control group and 29 in the experimental group.

After the initial assessment, parents who had infants in the experimental group participated in a training session on the use and method of the Numbers in Nappies programme that had been developed. The experimental group then participated in the Number in Nappies programme. The 34 infants who were part of the control group received no additional information or interaction, and a date for the second assessment in two months’ time was scheduled. The 29 infants in the intervention programme were assessed for a second time after an average of two months. Exactly the same process and assessment measures were used during the second assessment as in the first assessment, except for the ten problem-solving scenarios, which were presented in the second assessment only. The problems solving scenarios do not form part of the BSID (III) scales but contain the scenarios that are presented in the flashcard Numbers in Nappies programme. The same amount of time elapsed for the control and experimental groups between the first and second assessments. After the second assessment, parents who were part of the control group were afforded the opportunity to participate in the Numbers in Nappies programme. This was not compulsory.

Phase 3 was designed to ensure that all infants were given an equal opportunity to benefit from the Numbers in Nappies programme. The quantitative data collected in this phase helped to provide information to investigate the main objective of the research study.

3.3.4 Phase 4

Phase 4 of the study was qualitative and ran simultaneously with phase 3. Nine mothers were selected from the experimental group to be part of the focus group throughout the study. Stewart and Shamdasani (1990) recommend that a focus group should include about six to nine participants. The focus group met once every two weeks. At these meetings, these mothers gave feedback on their infants' development. The participation in the educational programme was monitored, and the researcher used a questionnaire-type check list to guide the focus group discussion. The questionnaire covered parent interaction (such as eye contact, body language, parent reaction, such as excitement and encouragement, and programme method, such as holding the flashcards at the correct distance and angle and for the correct length of time). Data was collected during the second assessment sessions by presenting ten problem-solving scenarios (see appendix 5) to the infants during the assessments and these results were noted and a comparison made between the infants in the experimental and control groups.

3.4 SAMPLING

3.4.1 Sample for phases 2

The sample for phase 2 of the study consisted of three groups of mothers/fathers with infants ranging from three to 26 months of age. The sample was selected from a local business in the Florida Hills area in Johannesburg. Group A comprised office staff in the middle- to upper- income brackets (12 participants), while groups B (9 participants) and C (11 participants) consisted of factory workers with minimal wage and poor home environments. A sample of 32 infants between the ages of three and 26 months provided qualitative feedback for phases 3 and 4 of the study.

Purposive sampling was used to select a sample for phases 3 and 4. Purposive sampling is used when looking for specific types of people to participate in a study (Durrheim, 1999). Purposive sampling involves the researchers using their own judgement about which respondents to choose, and selecting only those who best meet the purpose of the study. The advantage of purposive sampling is that researchers can use their research skills and prior knowledge to select participants appropriately (Bailey, 1987).

For the purposes of this study, the researcher decided to focus on black, white and coloured urban infants. The South African population is predominantly made up of these three ethnic groups (STATSSA, 2011).The infants all came from the middle-income sector as determined by the guidelines for middle class (see appendix 1) and lived in the Western Cape Province of South Africa. Infants between the ages of three and 12 months at the commencement of the research were recruited through local baby clinics, nursery schools and word of mouth. The total sample consisted of 63 infants. The initial sample consisted of 85 infants, but 17 were incorrectly assessed because the occupational therapist had assessed them according to age allocation instead of stopping the administration of assessment after zero had been achieved five consecutive times. A total of five infants did not continue with the research study owing to illness and personal time constraints.

The sample chosen was a convenience sample of infants who were available and fulfilled the following criteria for inclusion:

Inclusion criteria:

(1) mothers and infants who were available at the time of data collection
(2) mothers and infants who came from the middle-income sector
(3) only infants who were clinically normal in terms of health and development

Exclusion criteria:

(1) mothers and infants who were not available at the time of the assessment/data collection
(2) mothers and infants who were ill at the time of the assessment/data collection
(3) mothers and infants who did not come from the middle-income sector

This study was limited to infants between the ages of three and 12 months at commencement of the research. Only infants who had not been diagnosed with any developmental problems were allowed to participate in the study.

3.4.2 Sample for phases 3 and 4

The sample consisted of 63 mothers with infants between the ages of three and 12 months (either two weeks younger or older was acceptable). The experimental group consisted of 29 infants and the control group 34 infants. Nine parents from the experimental group formed part of the focus group for the qualitative part of the study. The infants were all deemed to be clinically normal, healthy infants with no history of any health or physical defects.

Research findings have indicated that socioeconomic differences influence performance in a variety of assessments for children from various cultural groups (Allan, 1992). Because these children have different social and education opportunities, only middle- income-group participants were selected. In this way, any expectations from low-income and underprivileged homes could be avoided. For the purpose of this study, the mothers and infants all came from middle-class backgrounds. The participants were all screened using the criteria as determined by the reports from Statistics South Africa. The participants needed to have the characteristics as defined by the statistical requirements for South Africa (see appendix 1).

The experimental and control groups were matched as evenly as possible according to the following variables: age, gender and race of the infant. Matching the experimental and control groups according to race helped ensure that any cultural differences that could have influenced the assessment results were taken into consideration. Gender differences in development do exist (Galsworthy et al., 2000), and although previous research has indicated that gender does not appear to be a major variable for the age group investigated in this study (Allan, 1992; Bhamjee, 1991), an attempt was made to include an equal number of boys and girls in the group. Matching in small studies is useful because there might not be sufficient subjects to adjust for variables later on in the study (Bland & Altman,1994). The total sample for this study was 46% males and 54% females. The gender distribution for the experimental group was 55% females and 45% males, and the gender distribution for the control group, 47% males and 53% females. The race distribution for the total sample was 17% coloured, 8% black and 76% white.

Table 3.1: *Frequency distribution for sample of ethnic group and gender*

Ethnic groups	Male	Female	Total
White	18	29	47
Black	4	1	5
Coloured	7	4	11

Total	29	34	63

Psychometric tests involve the use of language. Participants are required to understand the language of the assessment. Different cultural groups may assign different meanings to commonly used expressions (Samuda, 1983). The participants were therefore assessed in their home language where possible. Every attempt was made to ensure that all the subjects were afforded the best possible opportunity of understanding what was required of them during the selection and assessment process.

The sample was selected based on the mothers' willingness to participate in the research study. This selection was applicable to the sample for both the experimental and the control groups. In order to recruit these mothers, letters were sent to parents through preschools with the permission of the principals. An appointment was set up with the principals of the preschools to explain the purpose of the study. Letters were then sent home to parents or guardians informing them of the purpose of the study, and included in the letter was a consent form for participation in the study (see appendix 3). Local baby clinics were also approached in the same way. An appointment was made with the clinic manager to explain the purpose of the study, and the clinic sisters handed out letters to prospective participants. The mothers who wished to participate in the study responded to the letter via the schools, clinics or directly to the researcher. All interested participants were interviewed, the research study was explained in detail, and the participants were screened and asked to sign the consent form (see appendix 3).

Screening was required to determine if the participants would meet the requirements for a middle-class group. A brief questionnaire (see appendix 2) was given to the mothers. These screening items helped determine if all the infants were healthy with no apparent limitations. It also assisted in determining if the participants had the requirements to complete the intervention programme. The aim of this precautionary measure was to reduce the number of participants who might wish to opt out of participating in the research.

3.5 MEASURING INSTRUMENT

The BSID (III) was used to assess the infants in the selected sample. The BSID (III) is fully comprehensive, assessing all areas of development such as the motor, language and cognitive areas (Bayley, 2006).Both the experimental and control groups were assessed before and after the intervention programme.

The BSID (III) presents the infants with situations designed to produce observable responses. The responses are directly assessed by the Cognitive Composite Scale (91 items), the Language Composite Scale (97 items) and the Motor Composite Scale (138 items). The Language Composite Scale consists of the receptive communication subtest (49 items) and the expressive language subtest (48 items), while the Motor Composite Scale comprises the fine motor subtest (66 items) and the gross motor subtest (72 items). In addition to the three composite scales, each infant's parent or primary caregiver is required to complete two extra scales, the Social-Emotional Scale and the Adaptive Behaviour Scale. The parents are asked to completed the Behaviour Observation Inventory as well as the assessor on conclusion of the assessment to determine how often behaviours, such as positive affect and cooperativeness, are observed during testing (Greenspan, 2004). The data obtained from the social-emotional scales and the behaviour observation scales was used in the qualitative part of the study. The assessment should take approximately 50 to 90 minutes to administer. The time it takes to administer the test correlates to the age of the infant or toddler.

The starting point of the assessment requires the infant's chronological age to be determined. This age then correlates with a specific letter, which is the required starting point of the assessment. Each subtest of the BSID (III) is started according to the respective assigned letter correlating to the infant's age.

The BSID (III) assessment requires individual administration. The assessment takes approximately one hour to administer, depending on the age of the infant. The BSID (III) can be used to assess child development from one to 42 months, and for the purposes of this study, infants between the ages of three and 12 months were assessed.

Items on the scales are scored as correct by indicating 1 or incorrect by indicating 0, depending on the infant's ability to respond to the indicated action. The raw score adds up the infant's correct points. All items below the basal are scored as correct, and all above the ceiling as incorrect. Scoring requires the infant to obtain a score of 1 for all three of the first consecutive three items at his or her age specific starting point. If the infant does not achieve 1 for the first three consecutive items, then the assessment should be started at the previous age group specific starting point. Assessment is discontinued when the child scores five consecutive item scores of 0 (Bayley 2006). The social-emotional scale uses a six-point frequency rating (cannot tell, none of the time, some of the time, half of the time, most of the time and all of the time). The raw score is the sum of behaviour frequencies. The adaptive behaviour scale uses a four-point frequency rating (is not able, never when needed, sometimes when needed and always when needed). The two ratings on the Behaviour Observation Inventory completed by the assessor and the caregiver are based on Likert-type scales for how often a behaviour occurred during the observation (assessor rating) or how typical the behaviour is (caregiver rating). The qualitative comparisons are used with scores for intervention planning. Parent questionnaires are used for the socio-emotional and adaptive behaviour scales (Greenspan, 2004). In order to encourage the infant to be responsive and feel secure, parents are required to be present. It is important for infants to experience the assessment as enjoyable and therefore any fussiness, hunger or nappies that needed to be changed were accommodated. The mother was able to ensure that the needs of the infant were met. It also afforded the assessor an opportunity for behavioural observation of the interaction between mother and infant.

The BSID (III) provides four types of standardised scores, namely scaled scores, composite scores, percentile ranks and growth scores. Confidence intervals are available for the scales and developmental age equivalents are available for the subtests (Bayley, 2006).This research study made use of only the scaled and composite scores for analysis. A 95% confidence level was selected for the accuracy of the results for the assessment. Each infant was assessed individually according to his or her age, and scores were derived for each developmental area. Total raw scores are calculated for each subtest, and these are converted into scaled scores (mean 10 and SD 3) and composite scores (mean 100 and SD 15) (Bayley, 2006).

The scaled and composite scores can be compared to those of the norms. This enables one to determine how the infants are performing in each subscale in terms of qualitative descriptions. The descriptions are explained as follows: extremely low (69 and below), borderline (70 to 79), low average (80 to 89), average (90 to 109), high average (110 to 119), superior (120 to 129) and very superior (130 and above). Infants considered to be delayed were referred for further assessment. Since this study required data from the group, individual reports for each infant were only made available if the individual infant indicated developmental delays that required referral. These concerns were reported to the infant's mother. Any additional feedback that a parent felt he or she would like to have had to be requested. In this test, infants scoring 1.5 SD below the mean in two or more areas or 2 SD below the mean in one area are considered to be developmentally delayed (Bayley, 2006).

Training is required for the administration of the BSID (III). Training on the use of this assessment tool is available on DVD or on-site workshops (Pearson, 2009). It is vital that only trained professionals who know how to use and interpret the assessment should be allowed to perform this test. These include professionals with educational training for assessing young children such as psychologists, psychiatrists, speech and language therapists, occupational therapists and physiotherapists specialising in early intervention and developmental paediatricians (Pearson, 2009). The correct training and administration of the assessment ensure that the items designed to recognise developmental delays are identified accurately. Training is therefore essential in the administration of the BSID (III), which is known for its high reliability, test-retest reliability and validity (Pearson, 2009).

Problem-solving scenarios were presented at the end of the BSID (III) assessment session (see appendix 5) by the occupational therapist. These scenarios are not part of the BSID (III) scales but rather additional scenarios as presented in the Numbers in Nappies programme. These scenarios were shown to infants in both the experimental and control groups. The problem solving was presented in the same way as it was presented by the parents during the intervention programme. The responses were recorded as correct or incorrect. A comparison was made between the recorded data from the infants in both the experimental and control groups. The data was recorded based on observation and therefore the results are discussed and presented in the qualitative aims.

3.6 INTERVENTION PROGRAMME

The intervention programme consisted of two to three sessions per day of less than one minute each. Ten flashcards of shapes, colours or numbers were shown to the infant for approximately two to three seconds for each flashcard.

Before starting each session, the mothers had to ensure that their babies were content. The infant’s needs had to be anticipated to ensure that he or she was not hungry or required a nappy change. The infant was placed in a comfortable position in order to see the flashcards clearly, and any distractions such as television or noise needed to be addressed. During training, emphasis was placed on starting each flashcard session with a hug and creating a positive learning environment for the infant.

The sessions then started with the mother standing approximately one metre away from the infant, which ensured that the infant could see the flashcards clearly. The flashcards were shown individually for approximately two to three seconds while saying the name of the shape, colour or number in a clear and friendly voice. The ten flashcards should take 60 seconds per session, shown two to three times a day. The session ended with a hug and the mother saying, “Well done”, to the infant. The emphasis throughout the duration of the flashcard sessions should be on encouragement and the idea that learning is fun. Affection and stimulation are crucial ingredients for healthy infant development (Robokos, 2007).

The flashcards show the colours red, blue, green, yellow, orange, pink, purple, black, brown and grey. The following shapes are shown to the infant: the triangle, square, circle, diamond, rectangle, oval, semi-circle, star, hexagon and cross. The numbers are shown according to the ”dot method” (Doman & Doman, 2005) from numbers 1 to 30. The number flashcards were also used to introduce the concepts of addition, subtraction, multiplication, greater than and less than. The same ten flashcards are shown for the first five days, and thereafter two flashcards are replaced with two new flashcards every day. The repetition of the flashcards is based on the theory that the left brain is more logical and relies on repetition to absorb information (Schichida, 1993, 1997; Reynolds & Fletcher-Janzen, 2007).

Every three days, after the flashcard session, problem solving is presented to the infant. The problem solving encompasses showing two flashcards to the infant at the same time. For example, the mother holds up a pink flashcard and a flashcard with a triangle, then asks the infant, “which card is 10”, the infants respond either by looking at a specific card or reaching for the card, depending on age of the infant. The problem solving has not been included to test the infant, but rather to explore a natural part of development. Infants display a high level of interest in solving problems (Shonkoff & Phillips, 2000). Even very young infants will work to solve a problem; infants may solve the problem of trying to reach a toy that is out of reach by trying to roll towards it or by gesturing to an adult for help. Infants solve problems in different ways, “including physically acting on objects, using learning schemes they have developed, imitating solutions found by others, using objects or other people as tools, and using trial and error” (Shonkoff & Phillips, 2000, p. 148). The mother’s reaction to the infant’s problem solving is important; an infant who correctly solves the problem was praised with great delight. If the problem was solved incorrectly, the mother would show the correct card and clearly say the card’s name with enthusiasm. The emphasis was on promoting a positive environment. The session would end with the usual hug and “Well done” from the mother.

3.7 COLLECTION OF DATA

3.7.1 Phases 1 and 2

In phases 1 and 2, data was collected by means of the following:

(1) Structured interview: Mothers were questioned about their health, work, education, transport, daily routines and other factors that might affect infant care. The questions about the infant related to feeding, care, activity and development.

(2) Videotape of training and practicing method of programme

(3) Video clips from home videos/cellular phones of parents and their infants participating in the programme

(4) Fortnightly feedback discussion groups (30 minutes a group)

3.7.2 Phases 3 and 4

In phases 3 and 4 of the research study, data were collected by means of the following:

(1) Bayley Scales of Infant Development Third Edition (BSID III). A trained and professional occupational therapist assisted with the testing of the infants between the ages of three and 12 months.

(2) Focus groups provided data through feedback discussion groups on the development of their infants and observation. The milestone developmental norms and the Numbers in Nappies programme helped to direct the discussions.

(3) The problem solving included in the BSID (III) assessment session provided data on the cognition of the content of the intervention programme for qualitative data.

3.8 DATA ANALYSIS

The data that was collected and analysed was based on the results of the BSID (III) assessments. This data was analysed with the assistance of a statistician. Quantitative data analysis enabled the statistician to make statistical comparisons of the means on the indices and the total score. Raw scores were converted to scaled and composite scores. Data was summarised using means of composite scores for each subscale. Composite scores were calculated from the scaled scores. Descriptive and comparative analysis was used to evaluate data. Descriptive statistics of 95% confidence intervals were determined for each assessment. Confidence intervals were determined for all subtests, to aid in the precision of test scores. Testing was done at a 0.05 level of significance. Infants scoring one or more standard deviations below or above the norms were considered to be significantly delayed or advanced.

The qualitative part of the study consisted of a focus group that met every two weeks for feedback and discussion on the intervention programme. The Behaviour Observation Inventory that was rated by the parents and the assessor during the assessment sessions provided additional information for the qualitative data. The problem-solving scenarios presented during the assessments were scored as either correct or incorrect, based on the infant's response and calculated as an overall percentage.

3.8.1 Quantitative Analysis

To test the hypotheses for aim A: a Wilcoxon signed-rank test was used to determine if there was a difference in the experimental group's mean composite scores for each subscale (cognitive, language and motor development) before and after the intervention programme. The Wilcoxon signed-rank test was applied to the data from each subscale on the BSID (III), namely the cognitive, language and motor subscale.

To test for aim B: the Mann-Whitney U test was used to determine if there was a difference between the infants in the experimental group's and control group's mean composite scores for each subscale (cognitive, language and motor development) before and after the intervention programme. The Mann-Whitney U test was applied to the data from each subscale on the BSID (III), namely the cognitive, language and motor subscale.

The Mann-Whitney U test was also used to assess the roles of age and gender within the control and experimental groups. The assessment of age and gender variances was determined to exclude them as potential alternative conclusions.
Parametric and nonparametric tests were run on the sample data, and the results from both types of test resulted in the same conclusions. However, owing to the sample size, the results from the nonparametric tests were used in the results chapter for the quantitative data. Nonparametric tests require fewer assumptions about underlying population distribution and these assumptions are "fewer and weaker than those associated with parametric tests" (Siegel & Castellan, 1988, p. 34).

3.8.2 Qualitative Analysis

Qualitative research constitutes subjective, interpretive and contextual data (Auerbach & Silverstein, 2003). Measurements of validity in qualitative research have been developed to measure in line with concepts of the qualitative paradigm (Maxwell, 1992; Seale, 2003). Three concepts of validity are briefly discussed below, namely descriptive validity, interpretive validity and generalisability.
Descriptive validity forms the basis on which all the other forms of validity are built. Because it refers to the accuracy of the data (Maxwell, 1992), the data must be reported with precision. Without an accurate account of the formative data, all else is irrelevant (Glaser & Strauss, 1967). Since validity is dependent on interpretation, all variables in the research need to be carefully and accurately reported (Maxwell, 1992).

In qualitative research, generalisibilty can pose a problem, because it refers to applying the theory from a study universally (Auerbach & Silverman, 2003). Qualitative research is only concerned with the concepts and distinctive characteristics of a select group. A theory may therefore only be applicable to a similar group (Auerbach & Silverman, 2003; Strauss & Corbin, 1998). Qualitative studies do not need to be replicated, but provide an understanding of how the researcher arrived at a specific interpretation (Auerbach & Silverstein, 2003).

To determine aim C: the descriptive statistics from the adaptive behaviour mean composite scores were compared between the experimental and control groups before and after the intervention programme.

To determine aim D: the descriptive statistics from the social emotional functioning mean composite scores were compared between the experimental and control groups before and after the intervention programme. The mean composite scores from aim C and D were compared and explained according to the following guidelines: extremely low (69 and below), borderline (70 to 79), low average (80 to 89), average (90 to 109), high average (110 to 119), superior (120 to 129) and very superior (130 and above).

The focus group's discussions were noted. The responses of the focus group for the descriptive statistics were noted verbatim to ensure accuracy. The data was analysed using thematic analysis, which helped the researcher to interpret the data accurately. The data was separated into common themes that emerged from the feedback, as well as from the field notes made during observations of the mothers and infants participating in the programme. During the analysis of the qualitative data, the main aim of the study was the primary focus in the theme analysis. The analysis of the data was used in conjunction with the results from the social emotional and the behaviour rating scales assessments. In addition to the results from the social emotional scales and the adaptive behaviour rating scales, information was collected and analysed by presenting ten problem-solving scenarios (see appendix 5) to the infants. The occupational therapist presented these scenarios during the second assessment. The results of these problem-solving scenarios were noted and a comparison was made between the infants in the experimental and control groups.

3.9 ETHICS AND HUMAN SUBJECT ISSUES

Ethical clearance was obtained from the Department of Psychology at the University of South Africa (see appendix 6).

The aims and purpose of this study were explained verbally to the mothers of the infants who showed an interest in participating in the study. The participants were asked at the initial and screening meeting to sign a consent form relating to issues of confidentiality, nonmaleficence and beneficence. Participants were aware that this study was for a masters degree and that there was a possibility that findings would be published.

Because the assessment of infants can be sensitive, the safety and comfort of the mothers and infants were crucial. The mothers were the only individuals presenting the Numbers in Nappies programme to their infants and were present at both assessments. The BSID (III) assessment took on average 60 minutes, with a 60-day interval between each assessment. The mothers in the experimental group were required to show the flashcards to their infants two to three times a day for a period of 60 days. Each flashcard session should not have taken longer than a few minutes. The flashcard method was demonstrated during a training session at the start of the study in conjunction with the assessment.

Expectations by parents were managed by informing them that the research study focused on the group as a whole and that individual feedback was limited to situations in which there were major concerns in developmental delays.

Participation in this study was voluntary. Mothers were free to leave the study at any time during the course of the research project, and any concerns were immediately addressed.

Because everybody has the right to education in South Africa’s democratic society, the research study was designed in such a way to ensure that all the infants were afforded an opportunity to participate and have access to the Numbers in Nappies programme.

Early infant stimulation is of particular benefit to some of the lesser privileged racial and socioeconomic groups in South African society. However, as determined in phases 1 and 2, for the purposes of this study, a middle-income group was used to ensure that all the primary needs of infants such as food, shelter and clothing were met. This was to ensure that there would be no additional expectations. The research project could therefore focus primarily on the educational aspect of early infant development and in studying the effects of early infant exposure to numbers, shapes and colours.

SUMMARY

In this chapter, the research methodology was discussed. The research design for the study consisted of four phases. Phase 1 comprised a preplanning phase in which all the information was collected and the intervention programme was developed. Phase 2 involved a three-month qualitative study that used the programme on a trial basis. Feedback from the participants enabled the researcher to make changes and develop the intervention programme for phases 3 and 4 of the study. The sampling technique and sample were also highlighted in this chapter. The sample consisted of 63 infants from the middle-income sector, who were selected to participate in this study. The infants were sourced from preschools and local clinics in the Western Cape Province of South Africa. These infants were between the ages of three and 12 months. All participating infants were assessed with the BSID (III) before and after the intervention with an average of 60 days between each assessment. The infants were divided into an experimental group (who participated in the Numbers and Nappies intervention programme) and a control group.

In the quantitative part of the study, the mean composite scores from each subscale (cognitive, language, motor) of the BSID (III) assessment were compared for the experimental and control groups using a Mann-Whitney U test for independent samples and the Wilcoxon signed-rank matched-pairs test. The roles of gender and age were also evaluated in order to exclude them as any possible alternatives for significant differences between the two groups.

The qualitative part of the study used the descriptive statistics of the mean composite scores from the adaptive behaviour scale and the social emotional functioning scale to determine if the added stimulation from participating in the intervention programme had any effect on the infants. A focus group assisted in collecting the qualitative data required. Thematic analysis was used to explore common themes.

CHAPTER 4

QUANTITATIVE AND QUALITATIVE RESULTS

The data collected from the BSID (III) assessments were analysed and the results of these tests are presented in this chapter. The quantitative results were analysed to determine aim A and aim B. Using the Wilcoxon signed-rank matched-pairs test for aim A and the Mann-Whitney U test for independent samples for aim B. The qualitative results for aims C and D are discussed on the basis of the descriptive statistics from the adaptive behaviour scale and the social emotional functioning scale. Common themes that emerged from the focus group are also reported. The results are depicted graphically and in tabular format.

4.1 DESCRIPTIVE STATISTICS: EXPERIMENTAL AND CONTROL GROUPS

4.1.1 Composite score means at the first and second assessments

The data from the sample was assessed using the composite scores from each of the five different subscales (cognitive, language, motor skills, adaptive behaviour and social-emotional function scale). The group means and standard deviations of the composite scores for the control group and the experimental group for each subscale are tabulated in table 4.1.

Table 4.1: *Group means and standard deviations of the composite scores for the experimental group and the control group for each subscale*

Subtest	*Group*	*N*	*M*	*SD*
Cognitive[a]	experimental	29	97.97	9.34
	control	34	98.21	7.76
Language[a]	experimental	29	103.35	12.14
	control	34	103.18	11.43
Motor[a]	experimental	29	102.07	8.98
	control	34	99.12	12.20
Adaptive behaviour[a]	experimental	29	96.38	9.18
	control	34	94.91	9.77
Social-emotional[a]	experimental	29	119.38	6.82
	control	34	115.91	12.73
Cognitive[b]	experimental	29	109.90	12.92
	control	34	99.56	8.11
Language[b]	experimental	29	107.03	10.91
	control	34	102.23	13.70
Motor[b]	experimental	29	104.52	14.10
	control	34	100.91	13.64
Adaptive behaviour[b]	experimental	29	99.27	9.24
	control	34	97.13	9.77

Social-emotional[b]	experimental	29	130.63	12.36
	control	34	119.38	6.82

[a] first assessment

[b] second assessment

The composite means for all the subscales were numerically similar for both the experimental and control groups at the first assessment. An increase was observed after the intervention for the infants in the experimental group, especially for the cognitive subscale and the social-emotional functioning scale.

The profile plots for the cognitive subscale for the experimental and control groups from the first assessment to the second assessment is depicted in Figure 4.1.

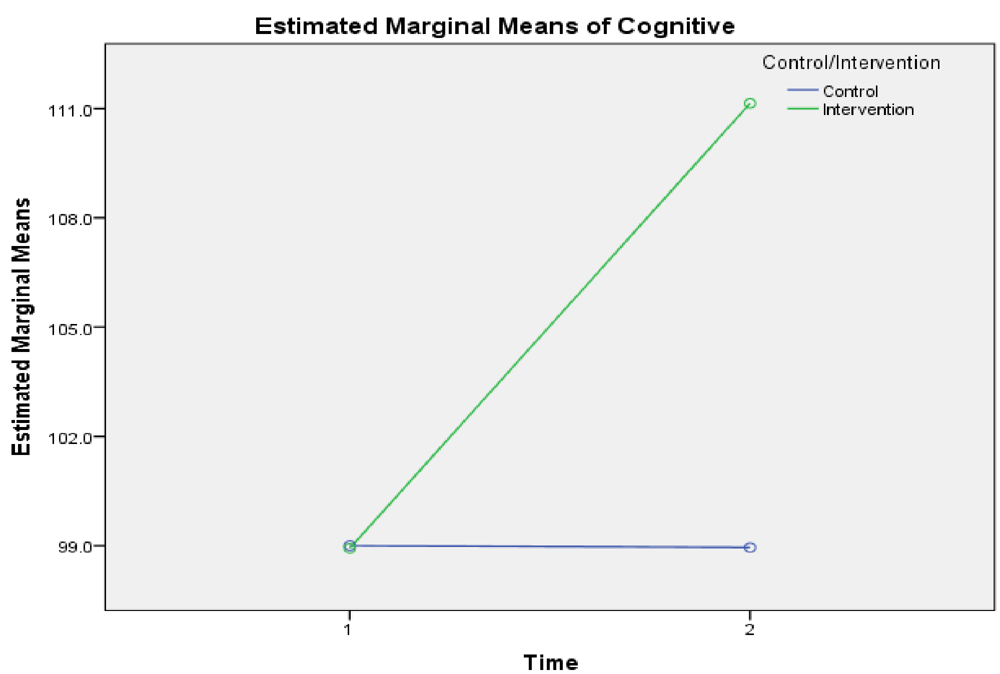

Figure 4.1: Estimated profile plots of the cognitive composite score means for the experimental and control groups

4.1.2 Composite score means at the first and second assessments according to age and gender

The group means and standard deviations of the composite scores for the cognitive, language and motor subscales for the experimental group for age and gender are tabulated in table 4.2.

Table 4.2: *Descriptive statistics for the experimental group for age and gender*

Subtest	*N*	*Group*	*M*	*SD*
Cognitive[a]	30	3–7 months	96.65	8.60
Language[a]	30	3–7 months	103.00	13.38
Motor[a]	30	3–7 months	100.18	9.81
Cognitive[b]	30	3–7 months	112.29	13.33
Language[b]	30	3–7 months	106.36	10.95
Motor[b]	30	3–7 months	107.47	12.62
Cognitive[a]	33	8–12 months	99.83	9.63
Language[a]	33	8–12 months	103.88	8.67
Motor[a]	33	8–12 months	104.75	6.27
Cognitive[b]	33	8–12 months	106.50	10.87
Language[b]	33	8–12 months	108.00	10.32
Motor[b]	33	8–12 months	100.33	14.45
Cognitive[a]	34	female	96.44	9.99
Language[a]	34	female	103.00	14.19

Motor[a]	34	female	100.00	10.09
Cognitive[b]	34	female	113.06	13.37
Language[b]	34	female	105.44	10.64
Motor[b]	34	female	107.31	12.99
Cognitive[a]	29	male	99.85	7.66
Language[a]	29	male	103.77	8.33
Motor[a]	29	male	104.62	6.05
Cognitive[b]	29	male	106.00	10.58
Language[b]	29	male	109.00	10.50
Motor[b]	29	male	101.08	14.12

[a] first assessment

[b] second assessment

The group means and standard deviations of the composite scores for the cognitive, language and motor subtests for the control group for age and gender are indicated in table 4.3.

Table 4.3: *Descriptive statistics for the control group for age and gender*

Subtest	*N*	*Group*	*M*	*SD*
Cognitive[a]	30	3–7 months	98.62	8.68
Language[a]	30	3–7 months	103.00	12.56
Motor[a]	30	3–7 months	99.77	12.87
Cognitive[b]	30	3–7 months	96.92	6.66

Language[b]	30	3–7 months	98.92	9.97
Motor[b]	30	3–7 months	98.77	13.92
Cognitive[a]	33	8–12 months	97.95	6.92
Language[a]	33	8–12 months	103.29	10.37
Motor[a]	33	8–12 months	98.71	11.44
Cognitive[b]	33	8–12 months	101.19	8.29
Language[b]	33	8–12 months	104.33	14.90
Motor[b]	33	8–12 months	102.24	12.95
Cognitive[a]	34	female	97.56	7.46
Language[a]	34	female	102.56	11.34
Motor[a]	34	female	99.89	11.36
Cognitive[b]	34	female	97.22	8.03
Language[b]	34	female	100.56	10.46
Motor[b]	34	female	99.17	12.31
Cognitive[a]	29	male	98.94	7.79
Language[a]	29	male	103.88	11.13
Motor[a]	29	male	98.25	12.66
Cognitive[b]	29	male	102.19	7.06
Language[b]	29	male	104.19	15
Motor[b]	29	male	102.88	14.36

[a] first assessment

[b] second assessment

4.2 NONPARAMETRIC TESTS

4.2.1 Age and gender factors considered

The factors of age and gender were considered before analysing the data for the specific aims. In this way, the roles of gender and age could be excluded as possible alternatives for the answers from the data analysis.

A Mann-Whitney U test for independent samples was conducted for each subscale to determine if, firstly, age, and, secondly, gender had an impact on the performance of the experimental and control groups.

Table 4.4: *Test statistics[a] for age[b] comparisons for the experimental group*

	Cognitive 1	Language 1	Motor 1	Cognitive 2	Language 2	Motor 2
Mann-Whitney U	75	94	69	79	97	77
Z	-1.21	-0.38	-1.50	-1.03	-0.22	-1.11
Asymp. sig. (2-tailed)	0.23	0.71	0.13	0.30	0.82	0.27
Exact sig. [2*(1-tailed sig.)]	0.25[c]	0.71[c]	0.14[c]	0.33[c]	0.85[c]	0.28[c]

a. Control/experimental = intervention

b. Grouping variable: age group (3–7 months and 8–12 months)

c. Not corrected for ties.

Table 4.5: *Test statistics[a] for age[b] comparisons for the control group*

	Cognitive 1	Language 1	Motor 1	Cognitive 2	Language 2	Motor 2
Mann-Whitney U	124	124	117	99	106	116

Z	-0.45	-0.45	-0.70	-1.37	-1.10	-0.74
Asymp. sig. (2-tailed)	0.65	0.67	0.49	0.17	0.27	0.46
Exact sig. [2*(1-tailed sig.)]	0.68[c]	0.68[c]	.51[c]	0.18[c]	0.28[c]	0.48[c]

a. Control/experimental = control

b. Grouping variable: age group (3–7 months and 8–12 months)

c. Not corrected for ties.

The Mann-Whitney U test results indicated that there was no significant difference between the two age groups (3-7 and 8–12 months), for the cognitive, language and motor subscales at the first and second assessment for either the experimental or control groups.

Table 4.6: *Test statistics[a] for gender[b] comparisons for the experimental group*

	Cognitive 1	Language 1	Motor 1	Cognitive 2	Language 2	Motor 2
Mann-Whitney U	81	104	86	103	101	89
Z	-1.04	-0.02	-0.82	-0.07	-0.16	-0.68
Asymp. sig. (2-tailed)	0.30	0.98	0.41	0.95	0.88	0.50
Exact sig. [2*(1-tailed sig.)]	0.31[c]	0.98[c]	0.42[c]	0.95[c]	0.88[c]	0.50[c]

a. Control/experimental = intervention

b. Grouping variable: gender

c. Not corrected for ties

Table 4.7: *Test statistics[a] for gender[b] comparisons for the control group*

	Cognitive 1	Language 1	Motor 1	Cognitive 2	Language 2	Motor 2
Mann-Whitney U	128	127	123	142	141	132
Z	-0.58	-0.61	-0.73	-1.03	-0.09	-0.14

Asymp. sig. (2-tailed)	0.56	0.54	0.47	0.30	0.93	0.68
Exact sig. [2*(1-tailed sig.)]	0.57[c]	0.55[c]	0.48[c]	0.33[c]	0.93[c]	0.70[c]

a. Control/experimental = control

b. Grouping variable: gender

c. Not corrected for ties

The Mann-Whitney U test results indicated that there was no significant difference for gender in all the subscales (cognitive, language and motor) at the first assessment and second assessment for either the experimental or control groups.

No statistical difference was indicated for the experimental and control groups for the factors of age and gender.

4.2.2 Aim A: Comparison of the experimental group's results before and after the intervention programme

The Wilcoxon signed-rank matched-pairs test was used for each subscale to determine if there were any significant differences in the experimental group before and after the intervention. The hypothesis for aim A was considered as follows:

> The null hypothesis (H0):
> There is no difference in the mean composite scores for each subscale in the experimental group before and after the intervention programme.
>
> The alternative hypothesis (H1):
> There is a statistically significant difference in the mean composite scores for each subscale in the experimental group before and after the intervention programme.

Table 4.8: *Ranks[a] for subscale comparisons in the experimental group before and after the intervention programme*

		N	Mean rank	Sum of ranks
Cognitive2 - Cognitive1	Negative ranks	0[b]	0.00	0.00
	Positive ranks	24[c]	13	300
	Ties	5[d]		
	Total	29		
Language2 - Langauge1	Negative ranks	9[e]	13	119
	Positive ranks	18[f]	14	259
	Ties	2[g]		
	Total	29		
Motor2 - Motor1	Negative ranks	13[h]	12	158
	Positive ranks	14[i]	16	221
	Ties	2[j]		
	Total	29		

a. Control/experimental = intervention

b. Cognitive2 < Cognitive1

c. Cognitive2 > Cognitive1

d. Cognitive2 = Cognitive1

e. Language2 < Langauge1

f. Language2 > Langauge1

g. Language2 = Langauge1

h. Motor2 < Motor1

i. Motor2 > Motor1

j. Motor2 = Motor1

Table 4.9: *Statistics[ab] for subscale comparisons in the experimental group before and after the intervention programme*

	Cognitive2 Cognitive1	Language2 Langauge1	Motor2 Motor1
Z	-4.32[c]	-1.68[c]	-0.76[c]
Asymp. sig. (2-tailed)	0.00**	0.09	0.45

a. Control/experimental = intervention

b. Wilcoxon signed-rank test

c. Based on negative ranks

** significant results $p < 0.05$

The composite scores for the cognitive subscale were rank ordered and a Wilcoxon signed-rank test was used to compare the ranks for $n = 29$ for the experimental group (*mdn* = 100). The pre-test and post-test results for the experimental group showed that the average of 60 days on the intervention programme introducing numbers, shapes and colours had a statistically significant effect on the infants (3–12 months) for the cognitive ability subscale, $z = -4.32$, $p < 0.001$.

The composite scores for the language subscale were rank ordered and a Wilcoxon signed-rank test was used to compare the ranks for $n = 29$ for the experimental group (*mdn* = 103). The pre-test and post- test results for the experimental group showed that the average of 60 days on the intervention programme introducing numbers, shapes and colours, did not have a statistically significant effect on the infants (3–12 months) for the language ability subscale, $z = -1.68$, $p = 0.09$.

The composite scores for the motor subscale were rank ordered and a Wilcoxon signed-rank test was used to compare the ranks for $n = 29$ for the experimental group (*mdn* = 103). The pre-test and post-test results for the experimental group showed that the average of 60 days on the intervention programme introducing numbers, shapes and colours, did not have a statistically significant effect on the infants (3–12 months) for the motor ability subscale, $z = -0.76$, $p = 0.45$.

4.2.3 Aim B: Comparison of the experimental group's and the control group's results before and after the intervention programme

The null hypothesis (H0):

There is no difference between the experimental group's and the control group's mean composite scores for each subscale before the intervention programme.

The alternative hypothesis (H1):

There is a statistically significant difference between the experimental group's and the control group's mean composite scores for each subscale before the intervention programme.

The Mann-Whitney U test was used to analyse the data for aim B.

Table 4.10: *Test statistics for the comparison of the experimental and control groups for each subscale before the intervention*

	Cognitive[a]	Language[a]	Motor[a]
N	63	63	63
Mann–Whitney U	482	507	582
Z	-0.16	0.19	1.23
Asymp. sig. (2-tailed)	0.83	0.85	0.22

[a] results at first assessment

The composite scores for the cognitive subscale were rank ordered and a Mann-Whitney U test was used to compare the ranks for n = 34 for the control group (mdn = 100) and n = 29 for the experimental group (mdn = 100). The results indicated that there was no significant difference between the two groups for the cognitive subscale before the start of the intervention programme, U = 482, p = 0.83, r = 0.02.

The composite scores for the language subscale were rank ordered and a Mann-Whitney U test was used to compare the ranks for n = 34 for the control group (mdn = 101) and n = 29 for the experimental group (mdn = 103). The results indicated that there was no significant difference between the two groups for the language subscale before the start of the intervention programme, U = 507, p = 0 .19, r = 0.02.

The composite scores for the motor subscale were rank ordered and a Mann-Whitney U test was used to compare the ranks for n = 34 for the control group (mdn = 99) and n = 29 for the experimental group (mdn = 103). The results indicated that there was no significant difference between the two groups for the motor subscale before the start of the intervention programme, $U = 582$, $p = 1.23$, $r = 0.16$.

The null hypothesis for each subscale (cognitive, language and motor) was therefore, not rejected in favour of an alternative hypothesis, as there was no significant difference between the control and experimental groups before the intervention programme.

> The null hypothesis (H0):
> There is no difference between the experimental group's and the control group's mean composite scores for each subscale after the intervention programme.
>
> The alternative hypothesis (H1):
> There is a statistically significant difference between the experimental group's and the control group's mean composite scores for each subscale after the intervention programme.

Table 4.11: *Test statistics for the comparison of the experimental and control groups for each subscale after the intervention*

	Cognitive[a]	Language[a]	Motor[a]
N	63	63	63
Mann–Whitney U	732	622	595
Z	3.32	1.78	1.14
Asymp. sig. (2-tailed)	0.00**	0.07	0.16

[a] results at second assessment

** significant results $p < 0.05$

The composite scores for the cognitive subscale were rank ordered and a Mann-Whitney U test was used to compare the ranks for $n = 34$ for the control group ($mdn = 100$) and $n = 29$ for the experimental group ($mdn = 110$). The results indicated that there was a significant difference between the two groups for the cognitive subscale after the intervention programme, $U = 732$, $p < 0.01$, $r = 0.42$.

The composite scores for the language subscale were rank ordered and a Mann-Whitney U test used to compare the ranks for $n = 34$ for the control group ($mdn = 103$) and $n = 29$ for the experimental group ($mdn = 105$). The results indicated that there was no significant difference between the two groups for the language subscale after the intervention programme, $U = 622$, $p = 0\ .07$, $r = 0.22$.

The composite scores for the motor subscale were rank ordered and a Mann-Whitney U test was used to compare the ranks for $n = 34$ for the control group ($mdn = 99$) and $n = 29$ for the experimental group ($mdn = 105$). The results indicated that there was no significant difference between the two groups for the motor subscale after the intervention programme, $U = 595$, $p = 0.16$, $r = 0.14$.

The significant difference in the results of the cognitive subscale between the two groups after the intervention programme meant that the null hypothesis could be rejected. The null hypothesis for the language and the motor subscale was not rejected in favour of an alternative hypothesis, because there was no significant difference between the control and experimental groups after the intervention programme for these two subscales.

The results for aim B therefore show that before the start of the intervention programme, both the experimental and the control groups were evenly matched. The results of the second set of hypotheses indicate that there was a significant increase in the cognitive ability of the infants in the intervention group. Age and gender as possible explanations for this increase could be excluded as previously determined.

4.3 QUALITATIVE RESULTS

The total sample was used to analyse the social-emotional and adaptive behaviour composite scores. These scores were compared between the first assessment and the second assessment for the control group and the intervention groups. Although the BSID (III) was used to assess the social-emotional and the behaviour rating scale, the scores are made through behaviour observations by the parent and the assessor – hence the results are reported as part of the qualitative study. The problem-solving scenarios of the concepts introduced in the intervention programme were observed on the total sample during the occupational therapist's assessment of the infants. The outcomes are reported as part of the observations for phase 4 of this study.

4.3.1 Aim C: Comparison of the experimental group's and the control groups results for the adaptive behaviour scale results before and after the intervention programme

The descriptive statistics of the behaviour rating scale revealed that there was a slight increase in the mean scores for both groups. There was, however, no indication that the intervention programme specifically (or per se) had any effect on the infants' behaviour. The experimental group's composite score mean was in the average range for the first assessment and second assessments. The control group's composite score mean was in the average range for the first and second assessments. The descriptive statistics for the adaptive behaviour mean composite scores were previously indicated in table 4.1.

4.3.2 Aim D: Comparison of the experimental group's and the control group's social-emotional scale results before and after the intervention programme

The descriptive statistics of the social-emotional scales showed that there was a large increase in the composite score mean of the experimental group in comparison with the control group. The experimental group had a composite score mean in the high average range for the first assessment and in the very superior range for the second assessment[1]. The control group had a composite score mean in the high average range for the first and second assessments. The large increase in results complements the social-emotional functioning theme that emerged from the focus group.

[1] This is the result of the large increase in composite score means between the experimental and control groups in the second assessment. A t-test was used to analyse the increase. This was not part of the quantitative study and the results would require further exploration. The t-test showed that the intervention programme had a significant effect on the social-emotional development of the infants in the experimental group, $t\ (7) = -2.68$, $p = 0.03$.

4.4 THEMES THAT EMERGED FROM THE FOCUS GROUP

The focus group consisted of nine parents and infants for the qualitative part of the study. The focus group's discussions were noted and thematic analysis used to analyse the data that had been collected. The data was separated into common themes that emerged from the feedback, as well as from the field notes made from observations of the mothers and infants participating in the programme.

The three main themes that emerged from the focus group discussions around the intervention programme were the infants' cognitive abilities, communication skills and social-emotional functioning.

4.4.1 Cognitive ability

The cognitive ability of an infant refers to his or her ability to think, reason, solve problems and learn new information about the environment that surrounds him or her (Piaget & Inhelder, 1973). Parents reported that it was difficult to determine if learning of the concepts was actually taking place, because infants between the ages of three and 12 months are unable to verbally communicate the concepts being introduced. Parents were therefore sceptical about whether the programme was actually teaching the concepts of numbers, shapes and colours. However, it was observed that the infants would look at the new flashcards for a lot longer than the flashcards they had seen in previous sessions. Infants showed a preference for the shapes and/or colours flashcards, as opposed to the flashcards that introduced the numbers concepts. "She is not interested in the numbers/dots, she likes the shapes and colours better" (participant 1, focus group notes, 02/02/2012); another parent commented as follows: "He definitely seems to prefer the colours to the shapes. It will be interesting as we go along to see if things change" (participant 2, focus group notes, 11/11/2011).

A problem-solving element was built into the programme where the parent who was participating in the programme would hold up two flashcards and ask the infant to identify one of the cards. “Today when I showed her 10 and green and asked which was 10, she looked at 10 this morning and this evening she reached out for the 10” (participant 3, email correspondence, 24/11/2011). Spontaneous reactions to the problem solving were reported to be correct, and delayed reactions would often lead to incorrect identification of the flashcards.

4.4.2 Communication

According to Zwaigenbaum et al., (2009), communication in infants is their ability to convey feelings, observations and intentions, by responding to the feelings, observations and intentions of others through nonverbal, symbolic and spoken language. Parents reported that the infants found the flashcard sessions enjoyable. “Michael is now four months old and giggling), he loves his flashcards and identifies the problem solving cards. It's very exciting” (participant 5, email correspondence, 08/12/2011), and “baby happy and enjoying” (participant 4, focus group notes, 12/03/2012). Enjoyment was communicated through smiles, and excited hand and feet gestures. A few parents reported anticipation from the infant for the session as soon as the flashcard folder was taken out. Communication was also observed during the problem solving. The infant would reach out for the flashcard, or alternatively look at the flashcard he or she thought was correct. “Today when I showed her 10 and green and asked which was 10, she looked at 10 this morning and this evening she reached out for the 10” (participant 3, email correspondence, 24/11/2011). Parents also reported that infants were easily distracted by their environment and parents had to ensure a quiet space with few distractions to enable them to communicate and introduce concepts from the programme. “Sy kyk mooi na die kleure veral en ook na die vorms. Maar ek moet seker maak daar is nie ander distractions of mense in die kamer nie)[2]" (paticipant 8, email correspondence, 08/11/2011)

4.4.3 Social-emotional functioning

According to Paige-Smith, Jones, and Rix (2008), social-emotional functioning is the ability to participate in developmentally appropriate interactions with other people, and still act in accordance with expectations. Parents felt that their moods had an effect on the flashcard session and this was reflected in the infant's response. Enthusiastic participation from the parent elicited excited and enthusiastic responses from the infant. Because the parents' faces were covered with the flashcards while showing the cards, some infants associated the session with a game. One parent commented as follows:, "we were playing peek-a-boo, and every time my face appeared she would giggle" (focus group notes, 09/11/2011). Parents who felt that they were not motivated to continue with the programme were the same parents who reported that they felt their infants were "getting bored with the programme" (participant 2, personal communication, 26/03/2012).

Parents felt that the intervention programme created an opportunity for using a structured activity to connect with the infant and made parents more aware of teaching concepts during playtime. "She knows her colours most of the time, she has these balls and I ask her the colours while she plays" (participant 9, email correspondence, 19/01/2013). Another mother (participant 6) reported that she applied the concept when she and her daughter were using transport: "I use colours and count cars, buses and almost everything we do I try to teach her" (focus group notes, 09/11/2011).

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[2] Translated – she looks at the colours nicely, and especially the shapes. However, I have to ensure that there are no other distractions or people in the room.

4.5 PROBLEM SOLVING

The infants who participated in the intervention programme were able to correctly identify a flashcard 73% of the time in comparison with the control group who were able to identify the correct flashcard 1.4% correctly.

SUMMARY

The data collected from the assessments using the BSID (III) was analysed by means of nonparametric tests, the Mann-Whitney U test and the Wilcoxon signed-rank test. The main aim was to evaluate the effect of the intervention programme on the infants by comparing the control group with the intervention group across the three subscales comprising cognitive, language and motor skills before and after the intervention programme. Gender and the two age categories of three to seven and eight to 12 months were also analysed for variances. The results of the data analysis indicated that the control and intervention group were evenly matched in the first assessment. The second assessment revealed that there was a significant difference between the experimental and control groups on the cognitive subscales. Gender and age group did not affect the experimental and control groups, and were therefore excluded as possible reasons for the increase in cognitive development.

The qualitative study indicated that there was no change in the adaptive behaviour of the infants. However, the social-emotional scale composite means indicated that there was an increase in the scores of the infants in the intervention programme, compared with the scores of those who were part of the control group.

Three common themes emerged from the focus group sessions, namely the cognitive ability of the infants, the way they communicate and their social-emotional functioning. It was difficult to assess if the infants were actually learning any of the concepts, but it was noted that infants were aware if new flashcards were introduced. The infants would look at the new flashcards for longer. Infants enjoyed the interaction with the parent during these sessions, but their enthusiasm was limited to the parent’s enthusiasm and motivation. Problem solving revealed that infants in the intervention programme were able to correctly identify a flashcard 73% of the time in comparison with the infants in the control group who could only identify a flashcard correctly 1.4% of the time.

Chapter 5

DISCUSSION OF RESULTS

The motivation for this study was the book, *How to teach your baby math: the gentle revolution* , by Doman and Doman (2005), and the results the authors claimed to achieve with the flashcard method of teaching numbers and mathematical concepts. The intervention programme, Numbers in Nappies, was loosely based on the concepts taught in the book, but was adapted to include shapes and colours. The combinations and daily routine of the programme were developed on the basis of the feedback and observations from the pilot study.

The study consisted of a quantitative and qualitative study. The quantitative aims of the study were, firstly, to determine if there was a difference in the experimental group's mean composite scores for each subscale (cognitive, language and motor development) before and after the intervention programme. The second aim was to determine if there was a difference between the infants in the experimental group's and control group's mean composite scores for each subscale (cognitive, language and motor development) before and after the intervention programme. The qualitative aims were, firstly, to determine if there was a difference in the adaptive behaviour of the experimental group as a result of added stimulation from their parents by means of the programme, before and after the intervention programme, when compared to the control group. The second aim was to determine if there was a difference in the social emotional behaviour of the experimental group as a result of added stimulation from their parents by means of the programme before and after the intervention programme, when compared to the control group.

The data from this study was collected from the two BSID (III) assessments for each infant, with an average of 60 days between the first and the second assessment. Data for the quantitative study was analysed using the Wilcoxon signed-rank matched-pairs test and the Mann-Whitney U test for independent samples. The effect of gender and age was explored using the Mann-Whitney U test for independent samples to determine if these two factors had any impact on the results of the data analysis. The Wilcoxon signed-rank test was used to analyse the pre-test and post-test results for the experimental group. The Mann-Whitney U test was used to compare the results of the first and the second assessment between the experimental group and control group for each subtest (cognitive, language and motor skills) to determine if the intervention programme had any effect on the infants' development.

In the qualitative part of the study, the descriptive statistics for the adaptive behaviour scale and the social-emotional scales were discussed. Three main common themes emerged from the focus group feedback, namely cognitive ability, communication and the social-emotional functioning of the infant. The results of these analyses are discussed in this chapter.

Evidence from and the limitations of the research study are also discussed and recommendations made for future research. The results are discussed in the same order as the results chapter.

5.1 DESCRIPTIVE STATISTICS: EXPERIMENTAL AND CONTROL GROUPS

5.1.1 Composite score means at the first and second assessments

A comparison of the descriptive statistics for the composite score means for the experimental and control groups indicated that the means were similar at the first assessment for both groups. The composite score means showed a substantial increase in the experimental group for the cognitive (M = 109.90, SD = 12.92) and language (M = 107.03, SD = 10.91) subscales, as well as for the social-emotional scale (M = 130.6, SD = 12.36). The mean composite scores for the control group showed no increase. The descriptive statistics were similar at the first and the second assessment across all five of the developmental areas. Since these findings provided tentative support for the value of the intervention programme, its significance required further exploration.

5.1.2 Composite score means at first and second assessments according to age and gender

The infants from the experimental and control groups were divided into gender as well as two age group categories of three to seven and eight to 12 months. The composite score means for the descriptive statistics showed interesting results in the comparisons made for the two age group categories and the gender comparisons for the experimental group. These observable trends in the composite score mean would require further exploration to determine any statistical significance.

The control group composite score results showed that both age group categories (3–7 and 8–12 months) and the gender results yielded similar results at the first and second assessment for the cognitive, language and motor subscales. No noticeable trends were evident between the two age categories or genders.

The experimental group for the three to seven month age group showed a greater increase in the cognitive and language subscale results between the first and second assessment in comparison to the eight to 12 month age group. The cognitive subtest results at the first assessment (M = 96.65, SD = 8.60) and the second assessment (M = 112.29, SD = 13.33) for the three to seven month age category showed a greater increase than the eight to 12 month category results at the first assessment (M = 99.83, SD = 9.63) and the second assessment (M = 106.50, SD = 10.87). The motor subtest results at the first assessment (M = 100.18, SD = 9.81) and the second assessment (M = 107.47,SD = 12.62) for the three to seven month age category showed a greater increase than the eight to 12 month group results at the first assessment (M = 104.75, SD = 6.27) and the second assessment (M = 100.33, SD = 14.45). The increase in the experimental group's composite score results for the two age categories supports the theory of a link between motor and cognitive development (Diamond, 2000). The increase in the composite score means in the three to seven month category in comparison with the eight to 12 month category raises questions for further exploration. It is possible that the flashcards as part of an intervention programme are more suitable for infants who have not yet reached their motor milestones such as crawling and walking and who are therefore not as active and easily distracted.

Observations of the experimental group composite score means for gender showed a number of interesting trends. The female composite score means (M = 113.06, SD = 13.37) for the cognitive subscale were higher than the male composite score means (M =106, SD = 10.58) at the second assessment. These observations can be supported by the fact that earlier development of the left side of the brain (cortex) in females gives them better memory-related skills (Stoppard, 2008). The intervention programme, which mainly targeted cognitive development, focused on mathematical concepts such as numbers, shapes and colours. Studies by Linn et al. (1985) and Levine et al. (1999) indicated that males only have an advantage in numeracy after the age of four, and this would therefore explain the trend for females having a higher composite score mean than the males.

The female composite score means (M = 105.44, SD = 10.64) for the language subscale did not show the same increase in the mean as the male composite score means (M = 109, SD = 10.50) at the second assessment. The gender differences found in studies by Haden et al. (1997) and Galsworthy et al. (2000) indicated that girls fared better in early language acquisition than males. This does not concur with the observation of the composite score means at the second assessment. However, one could infer that the intervention programme had some effect on the language development of the males, as these results were not evident in the control group.

The female composite score means (M = 107.31, SD = 12.99) for the motor subscale was higher than that of the males (M = 101.08, SD = 14.12) composite score means at the second assessment. However, the female and male composite score means were different at the first assessment. These observations do not really determine a trend and concur with findings from previous studies of differences in motor development between genders. According to Lima et al. (2004), motor development between genders appears to be unpredictable.

5.2 NONPARAMETRIC TESTS

5.2.1 Age and gender factors considered

Biddulph (2008) posits that biological gender differences are already evident in an unborn infant's brain, and the results of Galsworthy' et al.'s (2000) research indicate that girls achieve better results than boys in cognitive tests. However, a Mann-Whitney U test for independent samples indicated that there were no significant differences for age or gender for either the experimental or control group. The absence of significant results assisted the researcher to exclude the roles of age and gender as possible reasons for the results of the intervention programme, on the performance on the cognitive, language and motor scales. The result of this comparison is supported by the Multicentre Growth Reference Study, which measured the impact of gender on the development of infants between the ages of four and 24 months. No significant differences between the genders of the same age were found (US Department of Education, 2006). Richter et al. (1992) also found no significant differences between the male and the female scores on the cognitive and motor scales of the BSID.

5.2.2 Aim A: Comparison of the experimental group's results before and after the intervention programme

The Wilcoxon signed-rank matched pairs test was used for each subscale (cognitive, language and motor) to determine if there were any significant differences in the experimental group before and after the intervention. The pre-test and post-test results showed that an average of 60 days on the intervention programme had a statistically significant effect (z = -4.32, p < 0.001) on the cognitive ability of the infants (3–12 months). However, the language subscale (z = -1.68, p = 0.09) and the motor subscale (z = -0.76, p = 0.45) indicated no significant differences. The significant results are in agreement with other intervention studies conducted by Campbell and Ramey (1994), Chickgoudar and Khadi (2001), Mishra and Mohanty (1991) and Gratham and Christine (1994).These intervention studies all reported significant improvements in the cognitive development of the infants in the experimental group. However, the study by Chickgoudar and Khadi (2001) also reported significant improvements in the area of motor development. This could have been, because tangible and three-dimensional activities were included in the intervention progamme used on the infants between the ages of nine and 15 months. A number of other studies have also documented the fact that the development of cognitive abilities of children raised in an enriched environment is superior to that of children raised in a nonstimulating environment (Adey & Shayer, 1993).

Infants are mainly interested in learning from people even though they start to understand connections between features of objects, actions and their surrounding environment. Parents and caregivers play a vital role in supporting the cognitive development of infants (Madole & Oakes, 1999).Two types of brain development can be described, namely experience-expectant and experience-dependent. Experience-expectant development relies on everyday experiences early in life, whereas experience-dependent development happens throughout life. Individual experiences create opportunities for new growth and refine existing structures (Thompson, 2001). Stimulating environments for infants make use of these two types of brain development to acquire cognitive, language, motor and social skills. The acquisition of these skills occurs in the context of the physical and social environment in which the child is raised. Motor development has been found to be linked to cognitive development. According to Piaget, cognitive and motor development cannot be regarded as separate entities because cognitive development relies completely on motor functioning (Piaget & Inhelder, 1966). Cognitive development is the intellectual growth that starts at birth and continues to develop and grow into adulthood. This cognitive development takes place in all the systems of the brain and focuses on the way learning takes place (Gleitman, 1981). The findings of this intervention study and the intervention studies by Campbell and Rarney (1994), Chickgoudar and Khadi (2001), Mishra and Mohanty (1991) and Gratham and Christine (1994) revealed that the cognitive development of infants can be improved when they are nurtured in an environment that is physically and socially encouraging.

5.2.3 Aim B: Comparison of the experimental group's and the control group's results before and after the intervention programme

The Mann-Whitney U test results indicated that there was no significant difference between the experimental group and the control group for the cognitive ($U = 482$, $p = 0.83$, $r = 0.02$), language ($U = 507$, $p = 0$ .19, $r = 0.02$) and motor ($U = 582$, $p = 1.23$, $r = 0.16$) subscales before the start of the intervention programme. These scores were above the 0.05 alpha level and the experimental and control groups could be regarded as similar at the commencement of intervention programme. According to the Coalition for Evidence-Based Policy (2006), well-matched comparison groups are important in research studies, because they yield correct overall conclusions about the effectiveness of an intervention.

The results of the Mann-Whitney U test for the comparison of the two groups after the intervention programme indicated significant results for the cognitive subscale ($U = 732$, $p < 0.01$, $r = 0.42$). Although the language ($U = 622$, $p = 0.07$, $r = 0.22$) and motor ($U = 595$, $p = 0.16$, $r = 0.14$) scores showed an increase in the descriptive statistics for the experimental group after the intervention, the Mann-Whitney U test did not show a significant difference. The increase in all the composite score means could be anticipated on the basis of the close relationship between these different areas.

Developmental theories emphasise that both biological maturing of the brain and environmental shaping are essential in infant development. External and internal processes have an effect on the developing infant or child. Children are born with language abilities influenced by neuron connections in the brain and social interactions with caregivers (Papalia et al., 2009). Language and motor skills are encouraged more by caregivers than cognitive abilities in the early months of life (Rademeyer, 2010). This could explain the fact that even though there was an increase in language and motor composite scores, the differences between the results were not significant between the experimental group and the control group at the second assessment, because of parents' natural encouragement in these two areas. The significant difference in the cognitive results between the control and experimental groups could be explained by the parental awareness of cognitive stimulation created through the intervention programme and the daily flashcard activities shown to the infants.

5.3 QUALITATIVE RESULTS

5.3.1 Aim C: Comparison of the experimental group's and the control group's adaptive behaviour results before and after the intervention programme

The descriptive statistics of the behaviour rating scale revealed that there was a slight increase in the mean scores for both the experimental and control groups. The fact that the infants were slightly older at the second assessment could explain this. However, there was no indication that the intervention programme specifically had any effect on the infants' behaviour. The experimental group's composite score mean was in the average range for both the first and second assessments. The control group's composite score mean was in the average range for both assessments. Adaptive behaviour refers to the infant's ability to adjust and learn from the environment. The infant's adaptive behaviour is linked to the other areas of development – for example, if an infant struggles with language, this will affect his or her behaviour and the way he or she adapts to and socialises with such a challenge (Windsor, Glaze, Koga, & the BEIP Core Group, 2007). In other words, the stimulation an infant is exposed to helps to shape his or her brain and behaviour, which drives subsequent development (Zeanah et al., 2003). The infants who participated in the experimental and control groups did not show any developmental delays – hence a difference in the composite score means for the two groups should not necessarily have been anticipated.

5.3.2 Aim D: Comparison of the experimental group's and the control group's social-emotional scale results before and after the intervention programme

The descriptive statistics for the social-emotional scales showed that there was a fairly large increase in the composite score mean of the experimental group in comparison with the control group. The experimental group had a composite score mean in the high average range at the first assessment and in the very superior range at the second assessment. The control group had a composite score mean in the high average range for both assessments. The large increase in results complements the social-emotional functioning theme that emerged from the focus group and will be discussed under this theme in section 5.4.1. The increase in the social-emotional scale for the intervention group and the increase in the cognitive scale as mentioned in aim B are interrelated. Early experiences with social-emotional relationships that include caring and responsive interactions between parents and their infants are vital contributors to encouraging attachment (DeWolff & Van IJzendoorn, 1997; Van IJzendoorn & Sagi, 1999). These early social-emotional experiences are linked to long-term positive outcomes in both the social and cognitive areas of development (Landry, Smith, Swank, & Miller-Loncar, 2000).

5.4 QUALITATIVE THEMES THAT EMERGED

The three main themes that emerged from the focus group discussions around the intervention programme were the cognitive abilities, communication skills and social-emotional functioning of the infant.

5.4.1 Cognitive ability

Parents felt that it was difficult to determine if the infants were actually absorbing the concepts shown to them. A child's aptitude for learning is supported by families with the required interest, knowledge and resources to support educational development (Woodhead, 1998). Parenting style and cognitive development are connected. These two factors will differ according to the goal in mind, the family culture and the socialisation process (Darling & Steinberg, 1993). This indicates that the parents can influence whether the infant is actually absorbing or learning the information. Observations of 12-month-olds revealed that they respond to the label of an absent toy by looking at and gesturing towards the spot where it usually rests (Saylor, 2004). The more often a toddler sees an object and hears its verbal label, the more likely he or she is to recall a mental representation when he or she hears the object's name (Saylor, 2004). This could indicate that the infants were absorbing the verbal information from the flashcards by familiarising themselves with the label name for each flashcard. Motion directs the infant's attention to the interior of a compound figure (Aterberry & Yonas, 2000). The motion of the flashcards is constantly drawing the infant's attention to the centre of the flashcard where the concept has been placed. This argument does not necessarily claim that cognition is occurring, but it does establish that an infant's ability to process verbal and visual information is being utilised. Although qualitative observations make it difficult to determine if cognition is actually taking place, the quantitative study did reveal that there is a statistical difference between the infants who participated in the intervention programme and the infants who did not.

Parents noticed that infants would look at new flashcards longer than flashcards they were familiar with. New-borns have the ability to distinguish between a picture and its label; this is indicated by their preference for looking at a photo of their mother's face (Wellman & Phillips, 2001). A study of infants aged seven months revealed that they looked differentially longer at new subtle and nuanced visual cues. The infants were found to be influenced by the same cues and in the same way that adults are. It was concluded that infants display "postdictive" perceptual processing (Newman, Choi, Wynn, & Scholl, 2008).

Infants showed a preference for the shapes and coloured flashcards, as opposed to the flashcards that introduced the number concepts. According to Aterberry and Yonas (2000), infants show a preference for certain types of patterns and have a processing advantage for vertically symmetrical patterns. The number concepts are introduced as red dots and are randomly spaced across flashcards. They are therefore not as bold and angular as the shape and colour flashcards. However, Aterberry and Yonas (2000) also reported that infants between the ages of three and four months display sensitivity to above and below, and left and right, as long as the targets (in the current study, the "so-called "targets" were red dots) do not change across trials. By the age of six to seven months, infants generalise the spatial relations of above and below, and left and right across targets, but not between Infants appear to have an understanding of between by the age of eight to ten months. These findings suggest a developmental trend in the perception of infants (Aterberry et al., 2000).

5.4.2 Communication

The parents all reported the ability to interpret the communication from their infants when participating in the flashcard sessions. This communication forms a foundation for establishing language development. Early nonverbal communication skills are thought to provide a foundation for subsequent language development (Baldwin, 1995; Tomasello & Farrar, 1986). The parents were able to understand their infants' communication signals for enjoyment, boredom and distraction. However, this was not limited to the intervention group, but assisted in feedback on the programme from the intervention group. Behaviours such as looking, reaching and pointing are abilities that reflect progress in both communication and social development (Baldwin, 1995; Tomasello & Farrar, 1986). The programme does not teach language skills, but rather encourages daily scenarios that require communication and understanding between the infant and parent. Relationships between an infant's nonverbal communication skills and subsequent language development have been reported (Brooks & Meltzoff, 2005).

5.4.3 Social-emotional functioning

The debate continues on exactly when emotions appear in infants (Moissinac, 2003). A smile may express emotion as early as six weeks of age, but it is not until about six months that an infant's smile can be regarded as emotional and social (Moissinac, 2003). Through the focus group feedback, it was observed that the enthusiastic parents elicited enthusiastic responses from their infants and the parents whose motivation started to wane felt that their infants were bored. According to Moissinic (2003), this is possible, because infants often follow the emotions of their caregivers. The flashcard sessions encouraged active participation by the parent and the infant and this intentional action encouraged laughter from the infants, because they thought the parent was playing "peek-a-boo". Laughter begins at three to four months of age, and eliciting laughter in infants at this age often involves an action that deviates from the norm, such as the game "peek-a-boo" provokes (Trentacosts & Izard, 2006). These moments encourage bonding between the parent and the infant as well as the appropriate social and emotional responses. The main aspect of the infant and the primary caretaker relationship is not necessarily based on the quality of care or educational input, but rather on the quality of the nonverbal communication process between infant and parent (Segal, Glenn, & Robinson, 2013).

5.5 PROBLEM SOLVING

Problem solving during the second assessment revealed that the infants participating in the intervention programme did better than the infants in the control group. However, each infant made an attempt to participate in the problem solving.

In his work, Piaget indicated that at approximately seven to eight months of age, infants develop deliberate action sequences to achieve a certain goal. They solve simple problems, such as pulling on a blanket to get hold of a toy resting on its far end (Willatts, 1999). The infants all indicated which flashcard they thought was the correct one by either by reaching out or turning their eyes towards the flashcard. The existing evidence suggests that between the ages of nine and 12 months, infants begin to produce points that are clearly directed at objects (Woodward, Sommerville, & Guajardo, 2001), and observations of these actions conclude that pointing is an intentional, object-directed action (Carpenter, Nagell, & Tomasello, 1998; Tomasello, 1995, 1999).

5.6 LIMITATIONS OF THE STUDY

Convenience sampling was used to collect the sample for this study. This was deemed a weakness, because such a sample is generally not representative of the larger population. The sampling was done in the Western Cape and therefore limited a broader view to the larger population. However, this was a small-scale study, and the researcher never intended to provide any absolute values, but only to lay a foundation for similar studies in the South African context.

Only infants between the ages of three and 12 months were included in the study. Any conclusions drawn from this study should not be generalised to older children, because a developmental perspective needs to be maintained.
Proportional representation of the ethnic groups as it occurs per ratio in the population was not possible, because of the nature of the sample, and only three ethnic groups in South Africa were represented in the research sample.

Only children residing in urban areas were included in samples for this study, and this may have been a restrictive factor. Evidence supports the fact that urban children perform better than children in rural areas as far as cognitive skills are concerned (Kendell, Verster, & Van Mollendorf, 1988; Weisner, 1976). Hence, generalisation of the results should be limited to children in urban areas.

Although certain limitations were identified, these should not overshadow the contributions of the study. Ethnicity, socioeconomic status, gender and age all have a critical influence on infant development. However, one should never forget that each infant is a unique individual.

5.7 IMPLICATIONS OF THE STUDY

The results of this study indicate that the infants who participated in the intervention programme of numbers, shapes and colours achieved much higher mean composite scores than the control group in the cognitive, language and social-emotional functioning areas of development. This indicates that intervention by means of flashcards does have a significant impact on development in the first few months of life. Furthermore, the observation of composite score mean trends in this study indicated that infants between the ages of three to seven months benefited the most from this type of intervention for cognitive skill development. One can therefore infer that parents can provide cost-effective educational stimulation for their infants in a home environment, specifically in the area of cognitive development.

5.8 RECOMMENDATIONS

Owing to the poor socioeconomic situation of many infants in South Africa, parents struggle to provide cognitively stimulating homes for their children, because of financial and educational constraints, and they therefore they need support in this area (Brown, 2009). Although this study was on infants in the middle-income sector, the intervention programme can be made inexpensively – hence the recommendation for further studies of such an intervention programme among poorer socioeconomic groups. Without early intervention, many children born into economically disadvantaged families fail to reach their potential (Ramey & Ramey, 1999).

This research study simply lays a foundation for similar studies in South Africa and further research would be required with a larger and more representative sample population. One suggestion would be to develop the intervention programme to also include more three-dimensional and tactile toys. The BSID (III) assessment measure allows for the programme to be expanded in this way.

A longitudinal study on the sample from this study would provide insight into determining if the foundations that were laid in the first year of life with this intervention programme would have an impact later on in the child's school career.

5.9 OVERVIEW OF FINDINGS

The purpose of this study was to examine the effect of an intervention programme introducing numbers, shapes and colours in five areas of infant development. Specific attention was paid to the infants' cognitive ability, with the intervention programme relying on skills such as problem solving, memory, number sense and attention maintenance. These specific skills in cognitive development can be regarded as the foundation for understanding numerical concepts (Halberda et al., 2008) and are important in the introduction of numbers, shapes and colours. Although the cognitive ability of the infants was the focus and could be studied independently, this area of development was not explored exclusively, because of the interrelatedness (Viholainen et al., 2002) of the different developmental areas.

The participants in the sample consisted of 63 infants between the ages of three and 12 months. All the infants were from middle-income sector, which meant that any additional needs such as food, shelter and clothing did not have to be considered in addition to the intervention programme, especially with such young infants. The sample in this study consisted of infants from three different ethnic groups (black, white and coloured).

The sample consisted of a control group with 34 infants and an experimental group comprising 29 infants. Nine participants from the experimental group formed part of the focus group, which met every two weeks to give feedback and discuss the development of the infants and the experiences of the parents involved in the intervention programme.

The study collected quantitative data and qualitative data that was assessed and analysed in order to achieve the four aims of the research study. The BSID (III) was used to assess the three areas of development, namely cognitive ability, language skills and motor skills for the quantitative part of the study. The adaptive behaviour and social-emotional functioning of the infants were also assessed using the BSID (III), and this data was used in conjunction with the focus group feedback and problem-solving scenarios for the qualitative part of the study. The intervention programme was applied to the infants on a daily basis, two to three times a day for approximately one minute per session, over an average of 60 days. The infants in both the experimental and control groups were assessed using the BSID (III) by a trained occupational therapist both before and after the intervention programme. The data provided by these assessments was used to determine the findings of this research study.

A Mann-Whitney U test was used to assess the roles of gender and age in the experimental and control groups to eliminate them as possible conclusions for the results of the research study. The results indicated that there was no significant difference between the genders or the two age categories (3–7 and 8–12 months) for both groups. It was therefore concluded that any significant results were based on the impact of the intervention programme.

The findings for aim A, namely comparing the pre-test composite score means and the post-test composite score means for the experimental group, indicated that there was an increase in all three of the subscales (cognitive, language and motor) composite score means. The Wilcoxon signed-rank matched-pairs test was used to further analyse the data for each subscale (cognitive, language and motor) to determine if there were any significant differences in the experimental group before and after the intervention. The pre-test and post-test results showed that an average of 60 days involved in the intervention programme had a statistically significant effect ($z = -4.32$, $p < 0.001$) on the cognitive ability of the infants.

A Mann-Whitney U test was used to analyse the data for aim B. The composite score means between the experimental group and the control group were compared before and after the intervention programme. The results indicated that there was no significant difference between the two groups for the cognitive language and motor subscales before the start of the intervention programme. This was significant, because well-matched comparison groups are important in research studies to show correct overall conclusions about the effectiveness of an intervention (Coalition for Evidence-Based Policy, 2006).The results of the Mann-Whitney U test for the comparison of the two groups after the intervention programme indicated significant results for the cognitive subscale, ($U = 732$, $p < 0.01$, $r = 0.42$). Although the language and motor scores showed an increase in the descriptive statistics for the experimental group after the intervention, the Mann-Whitney U test did not indicate a significant difference.

The qualitative study for aim C revealed there was no effect on the adaptive behaviour of the infants. A slight increase was observed in the mean scores for both the experimental and control groups. It was concluded that a possible reason for this increase would be the infants' natural development during the period of time between the two assessments. Adaptive behaviour is usually assessed in circumstances where there are developmental concerns, because an infant's adaptive behaviour is linked to the other areas of development (Windsor et al., 2007). In this study, because all the infants were healthy and had no developmental delays, differences in the composite score means for the two groups should not necessarily have been anticipated.

The descriptive statistics for the social-emotional scales in the qualitative study in aim D indicated a fairly large increase in the composite score means of the experimental group in comparison with the control group. The experimental group had a composite score mean in the high average range for the first assessment and in the very superior range for the second assessment. The control group showed no difference in the composite score means between the first and the second assessment. The large increase in results complements the social-emotional functioning theme that emerged from the focus group.

Three main themes emerged from the focus group, namely the cognitive ability, communication skills and the social-emotional functioning of the infants. The increase in the social-emotional scale for the intervention group and the increase in the cognitive scale as mentioned in aim B were interrelated. According to Landry et al. (2000), these early social-emotional experiences are linked to long-term positive outcomes in both the social and the cognitive areas of development. The parents all reported the ability to interpret the communication from their infants when participating in the flashcard sessions. This communication forms a foundation for establishing language development. Relationships between an infant’s nonverbal communication skills and subsequent language development have been reported (Brooks & Meltzoff, 2005).

The problem-solving scenarios that were assessed during the second assessment showed that the infants who participated in the intervention programme were able to correctly identify a flashcard 73% of the time in comparison with the control group who were only able to identify a flashcard 1.4% correctly.

CONCLUSION

The results of the study show that an early intervention programme has the potential to increase an infant's cognitive ability and enhance his or her social-emotional functioning. "Emotion and cognition work together, jointly forming the child's impressions of situations and influencing behaviour, most learning in the early years occurs in the context of emotional supports" (Shonkoff & Phillips, 2000). Although this study has its limitations, it does lay a foundation for further South African infant studies that could stimulate and enhance the lives of the little ones who are ultimately the future of our country.

"Though not yet plentiful enough to meet the need,
such programmes are a promising beginning."
(L.E. Berk, 2011, on the development of early intervention programmes, p 232)

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http://www.famsa.org.za/

APPENDICES

Appendix 1: Screening for middle-income-group participants

This screening table is based on the definition of Statistics South Africa.

Tick or make an X in the relevant block

The participant needs to meet all of the following criteria:	**YES**	**NO**
• Lives in formal housing		
• Flush toilet in dwelling		
• Water tap in dwelling		
• Electricity is main light source		
• Electricity or gas is main cooking source		
• Has a landline phone or a household member has a cell phone		

Source: http://www.statssa.gov.za/PublicationsHTML/Report-03-03-01/

Appendix 2: Questionnaire

Date ____

Mother's /father's name and surname:__________________________

Child's name:______________________________________

Male:____ **Female:**_________

Child's date of birth:_________________________________

Contact number:____________________________________

Home language:_____________________________________

Questions for the mother or father:

1. What is your occupation?

   ____

2. What is your highest level of education?

   ____

3. What are your working hours?

   ____

4. What form of transport do you use?

   ____

5. How many hours a day do you spend with your baby?

   ____

6. Does your baby go to bed at the same time every night?

   ____

7. What activities do you participate in with your baby?

____

8. Who looks after your baby when you are at work?

____

9. Did you experience anything unusual when you were pregnant with this baby?

   Yes:________   No:_________

   If “yes” please explain.

____

10. Did any of the following occur during your baby’s birth?

    Transfusion ____

    Premature birth _____

    Breech birth _____

    Oyygen problems _____

    Foetal distress _____

    Caesarean section _____

11. What is your opinion about educational stimulation programmes for babies as early as six months old?

____

12. What are your expectations in participating in the Numbers in Nappies research project?

____

Appendix 3: Consent form

Numbers in Nappies Research for Early Infant Development

This is a consent form for all mothers participating in the research study.

A QUALITATIVE AND QUANTITATIVE STUDY OF THE COGNITIVE PROCESSING POTENTIAL OF INFANTS

Researcher

- Jacqueline (Jaqi) van Vuuren
- Contact number: 082 624 2488
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Purpose of the research

The overall objective of this study is to examine the question: What is the effect of early infant exposure to educational stimulation such as numbers, shapes and colours?

Specific aims

The main aim of this study is to examine what effect early infant exposure to number concepts, shapes and colours will have on the infant. The study will use the Numbers in Nappies programme as an intervention tool, the Bayley Scales of Infant Development (III) and field notes from observation and parent feedback in order to investigate the following:

Quantitative aims

a) to determine if there was a difference in the experimental group's mean composite scores for each subscale (cognitive, language and motor development) before and after the intervention programme

b) to determine if there was a difference between the infants in the experimental group's and control group's mean composite scores for each subscale (cognitive, language and motor development) before and after the intervention programme

Qualitative aims

c) to determine if there was a difference in the adaptive behaviour of the experimental group as a result of added stimulation from their parents by means of the programme, before and after the intervention programme when compared to the control group

d) to determine if there was a difference in the social emotional behaviour of the experimental group as a result of added stimulation from their parents by means of the programme before and after the intervention programme when compared to the control group

Description of the research

This is an invitation for mothers of infants who are three months old to participate in a research study over the next three months. As participants, the mothers will be trained to complete a three-month educational programme with their infants. The programme is simple to follow and only requires a few minutes of the mother’s time two to three times a day. The infants will be tested by a trained professional in order to examine the development of the infants at the beginning and end of the three-month period. The mothers and their infants will be required to attend all the assessments. A small focus group will be selected to provide weekly updates, attend discussion meetings and allow for observation while the mothers are working with their infants. The BSID (III) assessment will take 30 to 45 minutes and will only be required twice, once at the beginning of the research study and again after three months. The mothers will be required to show the flashcards to their infants two to three times a day for a period of three months. Each session at which the flashcards are shown should not take longer than a few minutes, and this will be demonstrated during a one-hour training session at the start the study.

Additional points

- Any changes that are made to the study, or if any information becomes available, the participants will be informed.
- Participants are free to withdraw from the study at any time during the research study.
- Focus group participants should understand that certain procedures will need to be followed to respect confidentiality.
- The researcher will retain and store the research data.

Access to research information

- The research results will be available to the Eureka Foundation for Early Infant Development.
- Participants will have access after the study to a general report of about half a page. Individual reports will only be made available should any major concerns be identified by the assessor. The mother of the infant will be notified and the information will be kept confidential.

Do you agree that any data collected from this research study may be used in further related studies?

YES _______ NO ________

Potential harm, injury, discomfort or inconvenience

This research study aims to benefit infants and because only the mothers will be working with their own infants, no known harm, injury, discomfort or inconvenience can arise from this study.

Potential benefits

- Participants might benefit from this research study by
  1. spending quality, structured time with their infants
  2. enhancing the mother and infant bond
- This research has the potential to benefit all infants in a similar manner in South Africa in privileged and unprivileged communities.

Confidentiality

- Confidentiality will be respected, and no information that discloses the identity of the participant will be released or published without consent unless required by law.
- Participants in the focus group will have limited confidentiality.

    1. The researcher is capable of promising confidentiality of information, but cannot promise that the other participants will observe one another's privacy.

Reimbursement:

- Participation in this research study is voluntary and the participants will not receive any remuneration or reimbursement.

Participation

- Participation in this research is voluntary. If you choose to participate in this study you may withdraw at any time.

I ________________________________ (name and surname), _______________________ (I.D. number) understand the research study and agree to participate.

Signature: ____

Appendix 4: Milestone developmental norms for infants

Infant development can be divided into the following four categories:

- *Social:* This relates to how your baby interacts with the human face and voice. Examples include learning to smile and coo. A social delay may indicate a problem with vision or hearing or with emotional or intellectual development.
- *Language:* Receptive language development (how well a baby actually understands) is a better gauge of progress than expressive language development (how well a baby actually speaks). Slow language development can indicate a vision or hearing problem and should be evaluated.
- *Large motor development:* Babies holding their head up, sitting, pulling up, rolling over and walking are examples of large motor development. Very slow starters should be evaluated to make sure there are no physical or health risks for normal development.
- *Small motor development:* Eye-hand coordination, reaching or grasping, and manipulating objects are examples of small motor development.

• **The first month** ▪ Can lift head momentarily ▪ Turns head from side to side when lying on back ▪ Hands stay clenched ▪ Strong grasp reflex present ▪ Looks and follows object moving in front of him or her in a range of 45 degrees ▪ Sees black and white patterns ▪ Becomes quiet when a voice is heard ▪ Cries to express displeasure ▪ Makes throaty sounds ▪ Looks intently at parents when they talk to him or her	**The second month** ▪ Lifts head almost 45 degrees when lying on stomach ▪ Head bobs forward when held in sitting position ▪ Grasp reflex decreases ▪ Follows dangling objects with eyes ▪ Visually searches for sounds ▪ Makes noises other than crying ▪ Cries become distinctive (wet, hungry, etc.) ▪ Vocalises to familiar voices ▪ Social smile demonstrated in response to various stimuli
The third month ▪ Begins to bear partial weight on both legs when held in a standing position ▪ Able to hold head up when sitting, but still bobs forward ▪ When lying on stomach can raise head and shoulders between 45 and 90 degrees	**The fourth month** ▪ Drooling begins ▪ Good head control ▪ Sits with support ▪ Bears some weight on legs when held upright ▪ Raises head and chest off surface to a 90 degree angle

▪ Bears weight on forearms ▪ Grasp reflex absent ▪ Holds objects but does not reach for them ▪ Clutches own hands and pulls at blankets and clothes ▪ Follows objects 180 degrees ▪ Locates sound by turning head and looking in the same direction ▪ Squeals, coos, babbles and chuckles ▪ "Talks" when spoken to ▪ Recognises faces, voices and objects ▪ Smiles when he or she sees familiar people, and engages in play with them ▪ Shows awareness to strange situations	▪ Rolls from back to side ▪ Explores and plays with hands ▪ Tries to reach for objects but overshoots ▪ Grasps objects with both hands ▪ Eye-hand coordination begins ▪ Makes consonant sounds ▪ Laughs ▪ Enjoys being rocked, bounced or swung
The fifth month ▪ Signs of teething begin ▪ Holds head up when sitting ▪ Rolls from stomach to back ▪ When lying on back puts feet to mouth ▪ Voluntarily grasps and holds objects ▪ Plays with toes ▪ Takes objects directly to mouth ▪ Watches objects that are dropped ▪ Says "ah-goo" or similar vowel-consonant combinations ▪ Smiles at mirror image ▪ Gets upset if you take a toy away ▪ Can tell family and strangers apart ▪ Begins to discover parts of his or her body	**The sixth month** ▪ Chewing and biting occur ▪ When on stomach can lift chest and part of stomach off the surface bearing weight on hands ▪ Lifts head when pulled to a sitting position ▪ Rolls from back to stomach ▪ Bears majority of weight when held in a standing position ▪ Grasps and controls small objects ▪ Holds bottle ▪ Grabs feet and pulls to mouth ▪ Adjusts body to see an object ▪ Turns head from side to side and then looks up or down ▪ Prefers more complex visual stimuli ▪ Says one syllable sounds like "ma", "mu", "da" and "di" ▪ Recognises parents
The seventh month ▪ Sits without support; may lean forward on both hands ▪ Bears full weight on feet ▪ Bounces when held in standing position ▪ Bears weight on one hand when lying on stomach ▪ Transfers objects from one hand to another	**The eighth month** ▪ Sits well without support ▪ Bears weight on legs and may stand holding on to furniture ▪ Adjusts posture to reach an object ▪ Picks up objects using index, fourth and fifth finger against thumb ▪ Able to release objects ▪ Pulls string to obtain object

▪ Bangs objects on surfaces ▪ Able to fixate on small objects ▪ Responds to name ▪ Awareness of depth and space begins ▪ Has taste preferences ▪ "Talks" when others are talking	▪ Reaches for toys that are out of reach ▪ Listens selectively to familiar words ▪ Begins combining syllables like "mama" and "dada" but does not attach a meaning ▪ Understands the word “no” (but does not always obey it!) ▪ Dislikes diaper change and being dressed
The ninth month ▪ Begins crawling ▪ Pulls up to standing position from sitting ▪ Sits for a prolonged time (10 minutes) ▪ May develop a preference for use of one hand ▪ Uses thumb and index finger to pick up objects ▪ Responds to simple verbal commands ▪ Comprehends "no no" ▪ Increased interest in pleasing parents ▪ Puts arms in front of face to avoid having it washed	**The tenth month** ▪ Goes from stomach to sitting position ▪ Sits by falling down ▪ Recovers balance easily while sitting ▪ Lifts one foot to take a step while standing ▪ Comprehends "bye-bye" ▪ Says "dada" or "mama" with meaning ▪ Says one other word beside "mama" and "dada" (“hi”, “bye”, “no”, “go”) ▪ Waves bye ▪ Object permanence begins to develop ▪ Repeats actions that attract attention ▪ Plays interactive games such a "pat-a-cake" ▪ Enjoys being read to and follows pictures in books
The eleventh month ▪ Walks holding on to furniture or other objects ▪ Places one object after another into a container ▪ Reaches back to pick up an object when sitting ▪ Explores objects more thoroughly ▪ Able to manipulate objects out of tight-fitting spaces ▪ Rolls a ball when asked ▪ Becomes excited when a task is mastered ▪ Acts frustrated when restricted ▪ Shakes head for "no"	**The twelfth month** ▪ Walks with one hand held ▪ May stand alone and attempt first steps alone ▪ Sits down from standing position without help ▪ Attempts to build two block tower but may fail ▪ Turns pages in a book ▪ Follows rapidly moving objects ▪ Says three or more words other than "mama" or "dada" ▪ Comprehends the meaning of several words ▪ Repeats the same words over and over again ▪ Imitates sounds, such as the sounds dogs and cats make ▪ Recognises objects by name ▪ Understands simple verbal commands

	▪ Shows affection ▪ Shows independence in familiar surrounding ▪ Clings to parents in strange situation ▪ Searches for object where it was last seen

Source: Adapted from http://www.americanpregnancy.org/firstyearoflife/firstyeardevelopment.html

Appendix 5: Problem-solving feedback

Ten problem-solving scenarios for the experimental and control groups at the second assessment

Problem cards	YES	NO	Comments
ORANGE / 4			
GREEN / 10			
YELLOW / 6			
PINK / 3			
BLUE / 30			
GREY / 5			
PURPLE / 1			
BROWN / 2			
SQUARE / 5			
TRIANGLE / 18			
OVAL / 1			
DIAMOND / 8			
RECTANGLE / 26			
HEXAGON / 7			

Method

- **Two flashcards are held up simultaneously (i.e. ORANGE and 4).**
- **Ask the infant about one card – that is, “Which one is orange? (See programme for more information).**

Appendix 6: Ethical clearance

UNISA university of south africa

Department of Psychology

25-08-2011

ETHICAL CLEARANCE OF A RESEARCH PROJECT INVOLVING HUMAN PARTICIPANTS

Project: The Cognitive Processing Potential of Infants: A Study of the Effect of Early Infant Exposure to Numbers, Shapes and Colours [*M A dissertation*]

Researcher: Ms. Jacqueline van Vuuren (UNISA student number: 43698905)

Supervisor: Prof. R van Eeden (Department of Psychology, Unisa)

The proposal was evaluated for adherence to appropriate standards in respect of ethics as required by the Psychology Department of Unisa. The application was approved by the departmental Ethics Committee without any conditions.

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