

MOVEMENT PROGRAMMES AS A MEANS TO LEARNING READINESS

by

DR SOEZIN KROG

**Submitted in accordance with the requirements
for the degree**

MASTER OF EDUCATION WITH SPECIALISATION IN GUIDANCE AND COUNSELLING

at the

UNIVERSITY OF SOUTH AFRICA

PROF D KRÜGER

JANUARY 2010

Student number: 797-539-2

I declare that **MOVEMENT PROGRAMMES AS A MEANS TO LEARNING READINESS** is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

SIGNATURE
(Dr Soezin Krog)

DATE

SUMMARY

Learning readiness is deficient in many first time school-going children. Learning readiness depends on a well-functioning neural network. Research has shown that movement as an early learning experience is necessary for optimal neural development. Presumably it is movement that activates the neural wiring in the brain. It influences neural organisation and stimulates the specific neurological systems required for optimal functioning and development of the brain. Some children are faced with motor proficiency deficits which may influence their learning and their readiness to learn. This study aimed at determining whether movement programmes are a means to promote and achieve learning readiness. A selected group of Grade two learners who participated in a specifically designed movement programme for ten weeks showed improvement in their levels of learning readiness based on their movement proficiency and academic level. Based on these findings, recommendations were made for the inclusion of movement in the school curriculum.

Key words: Movement; movement programmes; learning readiness; neurological development; sensory motor system; reflex system; gross motor development.

ACKNOWLEDGEMENTS

Upon completion of this research project it is my duty to express my sincere gratitude and appreciation to the following;

Prof Deidre Krüger, supervisor of this study, for her invaluable and professional guidance, enthusiasm and encouragement in all aspects of this study;

To the staff of the library of the University of South Africa for their professional and efficient assistance;

To my students for their inspiration to research continuously on movement;

To Dr Claude Fredericks and Dr Andrew Lewis for their encouragement to complete the degree;

Esta de Jager and Wim de Villiers for the professional design of all the diagrams and for their help with the final preparation of the manuscript;

Prof Eleanor Lemmer for her precision and thoroughness in the editing of the manuscript;

To my family and friends for the love and support during the duration of my studies;

All participants in this study.

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CHAPTER 1

INTRODUCTORY ORIENTATION, STATEMENT OF THE PROBLEM, AIM OF THE STUDY AND CLARIFICATION OF CONCEPTS

1.1 INTRODUCTION TO THE STUDY

Entry into formal school is an important milestone in the life of a child. When school beginners enter the formal school, the question is asked whether they are learning ready. Currently it is widely recognised that 'readiness' is a prerequisite for successful achievement at school. In this regard Goddard (2002:xvi) claims:

When children first enter formal school, it is generally assumed that they will be able to sit still, pay attention, hold a writing implement and get their eyes to make the movements necessary to follow along a line of print. Many children do acquire these skills without difficulty; others take longer because they enter the school system at a definite disadvantage in terms of their neurological development and therefore lack the necessary physical abilities to succeed.

In the early 1990s Corso (1993:6-7) maintained that many children in America entered elementary school merely because they have reached the "magic age of five". She found that many of these children were not 'school ready' due to changes in American society that required both parents to work and due to the lack of understanding of the three modes of learning: the auditory, visual and kinesthetic. Kinesthetic learners learn primarily through moving. Corso (1993:6) adds that teaching practices tend to omit the importance of movement and focus on fine motor skills, such as threading, writing, colouring and cutting.

Diamant-Cohen (2007:40-41) explains that early childhood educators need to focus on skills that enable a child to enter into a classroom ready to learn. School readiness is therefore seen as a combination of skills leading to school success, positive early literacy language experiences combined with physical and mental health, social skills of regulation, basic cognitive skills and curiosity and enthusiasm about learning. School success seems largely to depend on the child being 'ready to learn'. Pheloung (1997:36) adds that movement is also seen as a prerequisite for learning readiness. Movement is necessary for all growth and change. It plays a vital role in activating many mental capacities for the reason that it integrates and anchors new information and experiences into our neural networks. The notion of a link between movement and successful learning stems from the work of earlier theorists, such as Delacato (1959;1974), Cratty (1972, 1973), Kephart (1975) and Ayres (1979). These scholars believed that movement reflects neural organisation and provides the stimulation to neurological systems that are necessary for optimal development and functioning. Learning readiness therefore requires the effective functioning of lower level systems in order for the higher level systems to perform adequately.

Goddard Blythe (2000:156) campaigns that attention (A), balance (B) and coordination (C) constitute the primary ABC upon which all later learning depends. If the mentioned aspects are not developed by the time children enter school, they run the risk of developing specific learning difficulties. This is not because these children lack intelligence, but is purely because the basic systems fundamental to learning are not fully in place by the time they start school. With careful planning and meaningful movement, the educator should ensure the development of these skills.

Olds (1994:32) considers movement and action as essential to children's development in general and to intellectual development in particular. Movement is seen as the gateway to sensing, acting upon and being affected by the world around us. She further states that, according to Piaget, movement is essential to the formation of intellect. Piaget refers to the first stage of intellectual development as the sensory motor stage. This is when children experience the world primarily through their senses and motoric abilities. According to Olds (1994:32-33), Piaget argued that the sensory motor stage is the basis on which the subsequent hierarchy of all intelligence is built. Between birth and five or six years, children's bodies, as well as their minds, are the organ of intelligence. De Jager (2009:18) agrees with the previous statements and adds that babies 'talk' through movement. During the sensory-motor process the far senses (touch, smell, taste, sight, and hearing) and the near senses (vestibular, proprioceptive and kinaesthetic systems) are developed through movement. De Jager (2009:19) maintains that once the sensory-motor systems is stimulated and developed, it acts as a communication network, linking the baby and the environment. The brain plays a major part in responding to stimulation from the environment by creating neurochemical pathways to help develop new skills and abilities to meet the various requirements. It is important to realise that the baby not only needs to know what is happening outside of his or her body, but also what is happening 'inside' the body.

De Jager (2009:21-23) and Jensen (2000a:59-66) confirm that the brain forms a vital connection between the body and the environment. Babies are not born with the knowledge of their various body parts. They need to discover the various body parts, build networks between the brain and the parts and learn to control them via the neurochemical networks. The stimulation and development of the sensory motor loop provides an opportunity for babies to experience their surroundings, reach milestones and develop the whole brain. The supporting structures and networks enable the child to read, write and solve problems later in life.

Liddle and Yorke (2004:xxi) reason that if a child cannot crawl to the toy seen from across the room, he or she will forget about it. As a result of forgetting about it, the child does not explore its shape, colour, texture, and taste. Notably when children cannot physically explore something, they do not engage their mind to learn about it. Physical development is often neglected as educators often assume it occurs spontaneously. Thought is not given to the simple ways in which motor skills, strength and coordination can be developed.

Recent research conducted by Goddard Blythe (2006b:1) has provided growing evidence which supports the long held theory that control of balance, motor skills and the integration of early reflexes are linked to academic achievement. Many children underachieve as a result of immature motor skills. During the various trials conducted by the Institute for Neuro-Physiological Psychology (Chester in UK), a simple movement programme was implemented in various schools. As a result of this programme children showed improved coordination, visual-motor and auditory skills, as well as improvement in reading and comprehension.

Another well known movement programme which cannot be ignored, namely Move to Learn, was designed by Pheloung from Australia. This movement programme was designed to help the immature child develop to full potential and is still being offered at various places worldwide (Pheloung, 1997:105-108). The reason for choosing movement as the basis of the programme was that movement is considered the basis for growth and development. It is evident from this programme that the child's ability to organise the body enables him or her to organise him or herself at home (by getting dressed) and in the classroom (by getting school books in order). Movement is thus seen as the basis to help the brain integrate in preparation for academic work.

Pheloung (2003:53) identifies the lack or insufficient degree of movement during a child's development stages as the main contributor to most learning restraints. She mentions only a few: midline crossing problems, inability to do cross pattern walking, balance problems, inadequate messages to the brain from the joints and muscles, inadequate messages from the skin to the brain and immature body awareness. This results in a lack of learning readiness. Goddard (2002:123) adds to this argument by stating that the underlying factors overlap with the symptoms of the diagnostic categories of dyslexia, dyspraxia, attention deficit disorder and dysfunction of attention.

Fontaine, Torre and Grafwallner (2006:99-100) believe that quality early learning experiences contribute to the healthy development and well being of the child. Substantiating evidence exists regarding the critical role of the environment for optimal neurological development, especially in the early years. Their research is a precursor of quality early care programmes which will guarantee optimal school readiness. The five major areas which are critical for school readiness include health and physical development, emotional well-being and social competence, approaches to learning, communication skills, and cognition and general knowledge.

In the light of the previous discussion, the question can be raised whether South African children are prepared correctly for learning. Should the preschool and the primary school programme make better provision for movement programmes? This brings to the fore the primary question for this study: *What movement programme will enhance learning readiness?*

1.2 BACKGROUND TO AND INCENTIVES FOR THIS RESEARCH

1.2.1 Initial awareness

Inspiration for this research is drawn from my interest in physical education and sport, which extends over many years. My interest was encouraged by my upbringing in a sport orientated family. All the family members participated in athletics, sailing, hockey, cycling and running. Consequently, I pursued a sporting career in athletics specialising in javelin. During my athletic career, which started in 1976, I broke numerous school and provincial records. Probably my greatest achievement was obtaining Springbok Colours for athletics in 1982. I continued to break numerous South African as well as African records during the decade of the 80's for women's javelin. Another exciting achievement was in 1988 when I broke the South African and African record with a distance of 62.34 metres. I was ranked 46th in the world at the time and achieved the Olympic qualifying distance, but unfortunately South Africa was excluded at that time from international participation. In total, I won seven South African Championships titles and was chosen for the Springbok Team for seven years. Two of my brothers have also obtained Springbok Colours in Sailing. My sister was awarded Junior Springbok Colours for managing a South African canoeing team overseas. Concurrent with my performance on the sports field, I was determined to further my education. I commenced with tertiary studies in 1980 and in 1997 I obtained my doctorate at the University of South Africa (Unisa).

My professional career as a lecturer started in 1990 at Unisa and this provided me with numerous opportunities to do research in the field of movement, physical education and sport. I have lectured Movement, Physical Education and Sports Coaching for the past decade. I have also presented numerous workshops for schools regarding Movement, the importance thereof as well as how to implement it in the school programme. My inspiration for this research has been drawn from these experiences.

I have also trained in Holistic Approach to Neurodevelopment and Learning Efficiency (HANDLE) as well as Integrated Learning Therapy (ILT). Both HANDLE and ILT are based on an eco-systemic approach and comprise multidisciplinary and drug free alternatives for diagnosing and treating most learning and behaviour problems. Problems are seen to be linked to neurological immaturity and with the implementation of a movement programme, natural neurological development is encouraged. In 2006 I attended a workshop in Chester, United Kingdom regarding reflexes offered by Sally Goddard Blythe, a developmental therapist of the Institute for Neuro-Physiological Psychology. This provided better insight into the role of reflexes which enriched this study. Goddard Blythe's numerous publications have been acknowledged in this research.

Moreover, I presented a paper at the Move to Learn Conference in Sydney in 2006, where I met a dear friend, Barbara Pheloung, the developer of the movement programme, Move to Learn. She remains a great inspiration to me and those who are using the programme. This programme has been included in the study material for my undergraduate students completing a Bachelor of Education (Early Childhood Development) at Unisa.

My personal experience and academic training has provided insight into children's need for movement, its role in preparing them for learning and reasons why some children are unable to learn. The assessments of children which I have conducted and the movement programmes which I have designed for these children has provided ongoing inspiration for this particular research.

1.2.2 Exploration of the problem

Children bring their bodies to the classroom or it could be said their bodies bring them to the classroom. Yet most educators assume that only their minds are valued. Children spend most time indoors and their bodies are merely tolerated. Teachers dutifully schedule gross motor time within the curriculum but frequently this is only to have children use excess energy to render them more manageable during teaching. Educators need to understand the importance of physical development in young children's lives to plan for it as an integrated part of their total learning (Carter, 2002:1; Liddle & Yorke, 2004: xxi).

According to Jensen (2000a:60), proper brain function is dependent on early motor development. The age between two to six years old appears to be particularly critical to a child's motor development as it is during this period that muscle strength, coordination, balance, and spatial skills are developed which have a tremendous impact on cognition.

A large percentage of preschool children attend preschool and preschools vary in their preparation of children for the formal grade one year. Programmes vary in the provision of social, emotional, intellectual and physical development. The emphasis of programmes also varies as to what is considered important and necessary for learning readiness. Very few schools consider movement to be an important part of the curriculum. They often resort to free play instead of organised movement programmes (Liddle & Yorke 2004: xxi).

Both Pheloung (1997: 21- 24) and De Jager (2009:19) agree that motion is central to the needs of young children. Knowledge regarding child development is important as it gives clues as to how we can best teach children. During her years of involvement with movement, Pheloung (1997:21 -24) dealt with a number of children with learning difficulties. These children were found to have missed, or partly missed, some of these stages of child development. They also appeared to be immature in their language, their vision, their listening abilities or their movement abilities or all these things. A large number of children were observed to lack learning readiness and in the search for ways to help to deal with the problem, Pheloung (2006:26) developed a 'ladder of learning' also referred to as the 'pyramid of learning' (Pheloung, 1997:27). This ladder illustrates the process of learning and indicates which steps of becoming 'ready to learn' a child has to go through before he or she can achieve academic success. This ladder includes the development of the basic systems which are most vital for learning of which movement is an important component.

1.3 THE RESEARCH PROBLEM

Given the afore-mentioned research findings, there is evidence that movement forms an important building block in the foundation of a child's growth and development from birth and cannot be left to chance. This raises the question whether many children enter school without having had adequate opportunities to experience movement and do they have sufficient motor proficiency in order to be considered learning ready?

An analysis of the foregoing question led to the identification of the following sub-problems that are the central foci for this study:

- What is the neurodevelopment basis of human movement, the sensory system and the reflex system?
- What is the link between moving and learning and what essential learning takes place through movement?
- Which basic sensory systems are most vital for learning?

1.4 AIMS OF THE INVESTIGATION

The aim of this research is to investigate whether movement programmes are a means to learning readiness. With reference to the introductory remarks and the formulated problems for this research, a general aim and specific aims have been identified.

1.4.1 General aim

The general aim is to determine whether movement programmes are a means to learning readiness.

1.4.2 Specific aims

In order to determine whether movement programmes are a means to learning readiness and provide a possible solution for the research problem various specific aims have been formulated:

- To determine what the current motor proficiency level of a group of learners with regards to vestibular, proprioception, muscle tone, tactile, visual and auditory functioning is.
- To establish the learner's current state of learning readiness, according to his or her current academic level with regard to the one minute maths, one minute reading, the 7/8 group tests and the Bender Visual-Motor Gestalt Test.
- To determine if a specifically designed movement programme can improve a child's motor proficiency as well as current level of learning readiness.
- To establish which of the five sensory motor systems of learners are dysfunctional.
- Can learners be better equipped for learning by participation in a movement programme?

1.5 THE NATURE, APPROACH AND METHOD OF THIS RESEARCH

A literature investigation was used as the first step in gathering information to constitute the theoretical framework for the research. Information was obtained from scholarly articles, books, research reports, educational indexes, newspaper articles, internet websites and other relevant literature. Primary as well as secondary resources were utilised.

Against the background provided by the literature review, an empirical investigation using a quantitative approach was conducted to determine the motor proficiency of selected participants currently experiencing learning difficulties. Psychological media and selected motor tests were used to gain insight into the participants' level of functioning. The data obtained was analysed to draw conclusions and make the necessary recommendations.

A one group case study design, consisting of 14 participants in Grade 2, was implemented for this research. Case studies allow for intensive descriptions and analyses, as well as for an in-depth understanding of the researched phenomenon (Henning, 2004:41). The participants were selected by convenience sampling, that is, they were both accessible and informative rich. The advantages of convenience sampling are: it is less costly, easy to administrate, assures a high participation rate and generalisation is possible to similar subjects. Limitations are, however, that it is difficult to generalise to other subjects; it is less representative of an identified population; the results are dependent on unique characteristics of the sample; and a greater likelihood of error is due to experimenter or subject bias (McMillan & Schumacher, 2001:175). This method of sampling enabled me to evaluate the participants' current state of motor proficiency and the effect of a movement programme on their motor proficiency and learning readiness.

The approach in this study is of a neurodevelopmental nature. The problem areas that learners experience were evaluated in the light of the neurological organisation as it evolves from before birth. I made use of selected movement activities in order to create new connections in the brain, which would have occurred under normal development. The movement programme was implemented over a 10-week period. Thereafter, post-testing was conducted to determine any improvement in the learners' motor proficiency as well as any improvement in their learning readiness according to their academic level.

1.6 CLARIFICATION OF TERMINOLOGY

The research was specifically aimed at the neurodevelopment of the child, the importance of movement and its role in creating learning readiness. For the purpose of clarification, key terms that appear throughout the dissertation are defined as follows.

1.6.1 Learning

Goddard (2002:55) theorises that learning begins long before a child goes to school. In actual fact, it begins at conception and continues to grow in unison with the child's body throughout his or her natural life. By the time a child reaches school it is assumed that the basic systems necessary for academic learning have been established. Good teaching together with the child's willingness to learn result in the child achieving success.

Hannaford's (2005:15) stance is that learning is not all in our head. Contrary to all thinking, the body plays an integral part in all our intellectual processes from the earliest moments in utero, right through to old age. The body's senses feed the brain environmental information with which an understanding of the world is formed and from which is drawn when creating new possibilities. Further, it is movement that not only expresses knowledge but also facilitates greater cognitive function. Movement actually helps the brain grow as it increases in complexity. The entire brain structure is intimately connected to and grown by the movement mechanisms within the body. Hannaford (2005:94) maintains that it is seen as a progressive, constantly changing process that serves to enrich and expand our understanding throughout life.

Hengstman (2001: vii) is of the opinion that young children acquire knowledge by manipulating, exploring and experimenting with real objects. He sees them learning almost exclusively by doing and by moving. The main aim for purposeful movement is that it influences – and in turn is influenced by – motor, cognitive, and affective domains.

According to an educator quoted in Pheloung (1997:85), efficient academic learning requires different sections of the brain to communicate and work efficiently together. Goddard (2002:55) agrees with the importance of the brain in learning and believes that a child begins to learn long before he or she ever reaches the school going age. She adds that all learning takes place in the brain but it is the body which acts as the vehicle whereby all knowledge is acquired.

1.6.2 Readiness

The concept of school readiness has been defined and redefined for many years. There appears to be two types of readiness: a) readiness to learn, which is considered the level of development at which the child has the capacity to learn specific materials; and b) readiness for school, which entails a specific set of cognitive, linguistic, social, and motor skills that enables a child to assimilate the school's curriculum (Vo-Vu, 1999:1).

The definition given by Reber and Reber (2001:602) for readiness is: *“a position of preparedness in which an organism is set to act or to respond” or “state of a person is such that they are in a position to profit from some experience. The type of experience determines the conceptualisation eg. reading readiness, school readiness or learning readiness”.*

Diamant-Cohen (2007:41) is of the opinion that a child is considered ready for school if the child has developed readiness knowledge and skills in the years before entering elementary school. It is highly unlikely that if the child is not ready to enter kindergarten, he or she will catch up as the school years progress.

As early as 1947 it was noted that reading readiness seemed to coincide with the shedding of the first milk teeth and the eruption of the second tooth were indicative of other neurological maturity related to reading readiness. Despite investigation regarding the significant links between neurological maturity and performance on cognitive psychological tests, chronological age alone still remains the criteria on which a child is allowed to enter school (Goddard, 2002:xvi).

Until recently misunderstandings have existed as to what readiness is. Eklind (2008:1) reports that readiness does not reside in the child's head and skills needed to succeed are not knowing numbers and letters, but rather being able to communicate, follow instructions and work cooperatively with other children. The true test for school readiness must take into account the child's level of intellectual and social/emotional development, his or her experiential background and the classroom expectations the child will encounter. It is clear that this description does not mention the importance of movement or the development thereof.

Gallahue and Donnelly (2003:42) understand readiness to be conditions within both the individual and the environment that make a particular task appropriate for the child to master. The meaning extends beyond biological maturation and includes environmental factors that can be modified or manipulated to encourage or promote learning.

1.6.3 Movement

Movement refers to all human movement, which is affected through the reflexes and later by the purposeful use of the muscles. Movement plays a vital role in brain development as well as in the development of efficient functioning of the perceptual, sensory and motor systems (Keogh & Sugden, 1985). Gallahue (1993:13) considers movement as the vehicle by which children explore all that is around them. It serves as a tool to enhance perceptual-motor and cognitive concept learning and promotes the development of a positive self-concept and positive socialisation.

Movement refers to the physical and entire motor development process from infancy to old age. It also encompasses the developmental patterns of basic motor skills at all age levels (Espenschade & Eckert, 1980: vii). Movement lies at the heart of learning. Learning, language and behaviour are all linked in some way to the function of the motor system and the control of movement (Goddard, 2002: xvi). It is known that children have an insatiable desire for movement, but very often, educators and parents suppress the desires of the child and believe that they only learn when they are sitting still and paying attention.

Liddle and Yorke (2004:7) confirm in their research that movements comprise both automatic and voluntary responses to stimuli. They believe that to fully understand how we move, requires a closer look at all the components of both the mentioned responses. By doing this it is possible to see how they are processed by the central nervous system.

1.6.4 Maturation

According to McMillan and Schumacher (2001:190), maturation refers to the changes in the subjects of a study over time that affects the dependent variable. They also see part of growing older as development and change.

Papalia, Olds and Feldman (2004:9) suggest that many typical changes of infancy and early childhood seem to be tied to maturation of the body and brain. They see maturation as the unfolding of a natural sequence of physical changes and behaviour patterns which include readiness to master new abilities such as walking and talking.

1.6.5 Central Nervous System (CNS)

The central nervous system (CNS) informs the body about itself and the world around it and enables the body to react to this information. The CNS has to actively identify, integrate and interpret incoming sensory stimuli, and produces electrochemical impulses that are distributed via peripheral nerves to generate responses to the environment and internal conditions (Cheatum & Hammond, 2000:40).

1.6.6 Neurological organisation

Neurological organisation is considered a physiological condition that exists when all neural development has progressed optimally without interruption. It is further stated that the process of neural organisation is an interdependent continuum: if lower levels are incomplete, all succeeding higher levels are affected (Delacato, 2006:1).

Hager (2006a:2) reports that neurological organisation to be the degree in which the CNS, in particular the brain, provides all the capabilities necessary to relate successfully in the environment. It is considered the process by which a human being achieves his or her potential, subject to environmental forces. The development of the brain is dynamic, starting at birth and continuing throughout life. The process of neurological organisation can be slowed, completed halted by injury or by environmental deprivation. It can also be increased by carefully planned environmental stimulation.

1.6.7 Neuro plasticity

According to Cheatum and Hammond (2000:34) neuro plasticity refers to the ability of the brain to change in response to new demands or sensations from the environment. This occurs throughout life, yet mostly during a child's early developmental stages. The neurons in the brain have the ability to make

new connections with other neurons and to create new pathways. The child's response to a new stimulus increases the dendrites (connections) between neurons. Neurons have been found to have the ability to change neurological pathways. Plasticity allows a child to form new neurological pathways, for example, changing the way a child holds a pencil. With the help of the teacher and repetition, a new way of holding the pencil is practised. New connections between different neurons are superimposed over the old pathway.

1.6.8 Reflexes

Reflexes enable the maturing child to interact effectively with his or her environment. In order to survive immediately after birth, a child is equipped with a set of primitive reflexes which are designed to ensure immediate response to the new environment and to these changing needs. Primitive reflexes are automatic, stereotyped movements, directed from the brain stem and executed without cortical movement. These reflexes have a limited life-span. The primitive reflexes emerge at birth and should be inhibited by six to twelve months at the latest (Goddard, 2002:1).

Primitive reflexes lay the foundations for later functioning. They later make way for the postural reflexes which form the framework of our effective functioning. The postural reflexes are mediated from the level of the midbrain and their development signifies the active involvement of higher brain structures over brain stem activity. They are a sign of increased maturity in the CNS. These reflexes are further concerned with posture, movement and stability (Goddard, 2002:27).

According to O'Dell and Cook (1997:14), reflexes form a vital link in that they provide a foundation for all motor development. Reflex development comes first followed by gross motor development and then fine motor development. If one of these levels is not properly developed, it could spell trouble for the levels above it.

1.6.9 Learning difficulties

The term learning difficulties was used since the early 1960's for at least five decades to describe learners who experience serious difficulties in one or more of their basic learning areas, which include reading, spelling, writing and mathematics. Nowadays, in many countries this term has been changed to 'learning impairments' as this refers only to the inabilities within the learner and not to the learner as a disabled person (Landsberg, Krüger & Nel, 2005:365).

Even though the term learning disabilities appears in numerous publications around the globe, in South Africa the term has recently been replaced with the term 'learning impairment'. It is a general term which refers to a heterogeneous group of neurological disorders in the basic psychological processes of the brain and which manifest in difficulties with language (speaking, reading and writing) and/or mathematical calculations. Excluded from this definition are learners who experience learning problems

as a result of hearing, visual, motor, intellectual impairments, cultural or economic disadvantages (Landsberg et al 2005:364).

For the purpose of this study the term learning impairments is used unless quoted as learning disabilities by the authors in their research.

1.7 THE STRUCTURE OF THE RESEARCH

The ensuing chapters concur with the components of this research:

- **Chapter 1** consists of an introduction orientation, statement of the problem, aim of the research, the nature and course of the research and the clarification of concepts.
- **Chapter 2** is devoted to a literature study in which neurodevelopment basis of human movement, the sensory systems which are vital for learning, as well as the role of the reflex system in the neurological organisation are discussed.
- **Chapter 3** contains an extensive literature study regarding the link between movement and learning readiness.
- **Chapter 4** gives an explanation of the research design. This chapter indicates the research approach, the sampling, ethical measures and the process used to gather the data.
- **Chapter 5** describes the empirical quantitative research design. This chapter is aimed at determining the motor skill proficiency of a selected group of Grade 2 learners with learning difficulties and the impact of a specially designed developmental movement programme on their learning readiness.
- **Chapter 6** includes the findings, recommendations and conclusion.

1.8 DELIMITATIONS OF THE STUDY

The focus of this research is on the motor development as one of the requirements for learning readiness. This study is limited to research into the functioning of the brain and the acceptance that movement is responsible for the structure of the brain as well as the proven plasticity that through movement the brain can be restructured.

This study has been narrowed down to determining the level of movement proficiency of a selected group of learners in Grade 2, with regards to the functioning of the five sensory motor systems, namely vestibular, proprioception, tactile, visual and auditory systems. These systems need to be adequately developed in order to prepare the child for learning readiness.

1.9 CONCLUSION

The development of movement cannot be left to chance. It has been suggested that the foundations for body management abilities are laid at an early age and appropriate movement experiences help to create neural networks in the developing brain. Brain research has taught many valuable lessons about how infants learn and why early experiences are so critical for their development. We are aware that the brain is not fully developed at birth and that genes and experiences influence the brain's formation and functioning. It has also been stated that early learning experiences are important in the preparation for learning readiness. I am of the opinion that movement plays a pivotal role in creating valuable learning experiences. Motor development follows a hierarchical sequence and results from growth and development of the central nervous system.

It is for this reason that a literature study of the neurodevelopment basis of human movement is required. The role of reflexes in the development of the child, the sensory motor systems and learning readiness will be covered in the second chapter of this study.

CHAPTER 2

THE NEURODEVELOPMENT BASIS OF HUMAN MOVEMENT

2.1 INTRODUCTION

This chapter is devoted to a literature study regarding the neurodevelopment basis of human movement. The research question which is considered is: What is the neurodevelopment basis of human movement, the sensory system and the reflex system? In order to understand neurodevelopment and human movement a brief discussion is firstly required regarding the systems which control movement. One must also not forget that movement originates in the brain as stated in chapter 1. Further, research has identified the relationship between gross motor ability in children of preschool and cognitive indicators in those at school age. Neuro-imaging has indicated that common brain structures are used for both motor and cognitive performance (Piek, Dawson, Smith & Gasson, 2008:668-680). Espenschade and Eckert (1980:125) emphasise the sequential interrelationship of both the intellectual and motoric functional development to the structural development of the brain. These researchers recognise the essential role of early motor experiences as a basis of perceptual and, subsequently, conceptual development.

Of importance to this section are the brain structures which are used for motor functioning. Special mention is made of the central nervous system and the brain, including their basic structure and manner of functioning which will be discussed as background information only.

2.2 STRUCTURES OF THE BRAIN

The brain comprises many separate entities which are all interlinked and dependent upon each other. Movement originates in the brain and the central nervous system and it is influenced by their functioning. Every movement that a person experiences is controlled by the nervous system (Figure 2.1). The nervous system is made up of the brain, spinal cord and a network of nerves which forms the body's control centre. The brain works out which movements the body needs to make and in which particular order they need to follow. The message is then sent out to the muscles through the nerves. The nervous system is the slowest of all the body's systems to develop fully (Macnair, 2005:36-41).

2.2.1 The central nervous system

The nervous system's role is to pass messages from one part of the body to another. It consists of nerve endings which reach into all parts of the body. The nervous system is divided into three parts, namely the central nervous system (CNS), the peripheral nervous system (PNS) and the autonomic nervous system (ANS). The *central nervous system* consists of the brain and the spinal cord. The spinal cord which runs along the inside of the backbone acts as a pathway, carrying millions of nerve impulses

between the brain, the limbs and the trunk. The central nervous system governs prenatal and early developmental reflexes as well as reactions that are involuntary (Cheatum & Hammond, 2000:40-41).

From the CNS forty three pairs of nerves branch: twelve come from the brain and thirty-one from the cord. These divide and snake among the organs and tissue, and filter into every tiny nook and cranny to form the peripheral nervous system (Parker, 2007:68-69; Hall, 2005:14 & Walker, 2003:76-77).

The *peripheral nervous system* consists firstly of all the sensory nerves which feed information into the spinal cord and brain. These sensory nerves contain sensory neurones. Secondly, the peripheral nervous system consists of the motor nerves which carry messages to other parts of the body from the brain and spinal cord. Motor nerves contain motor neurones and mixed nerves contain both sensory and motor neurones.

Sensory neurones are usually connected to motor neurones by intermediate neurones (also known as inter neurones). Sensory, intermediate and motor nerves have gaps between them called synapses (Central nervous system, 2009; Parker, 2007:68-69).

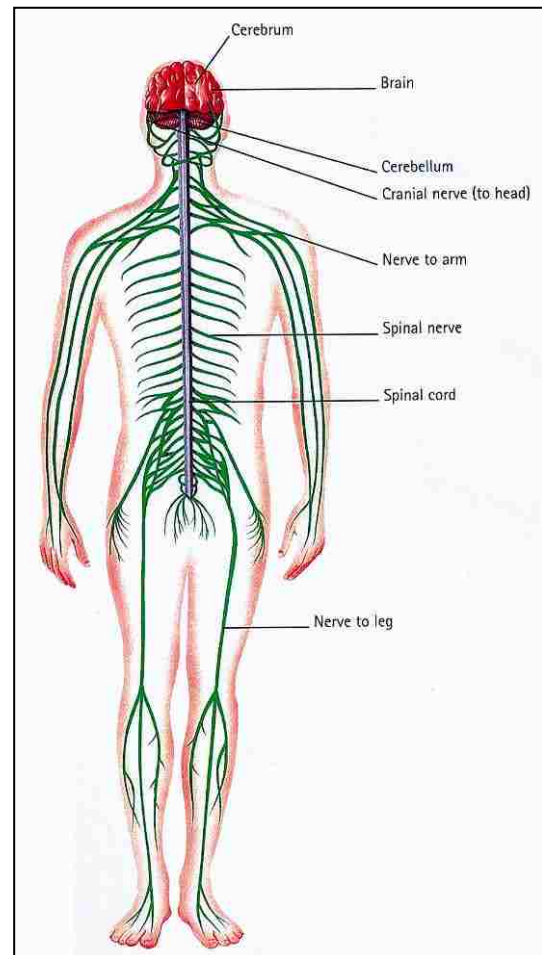


Figure 2.1: The nervous system

Source: Hall (2005:14)

Walker (2003:78-79) elaborates on the three types of neurons. Firstly, the *sensory neurons* are triggered by physical stimuli, such as light. Secondly, *association neurons* are triggered by sensory neurons, which process the information from the sensory neurons which then issue outgoing commands. Commands are then passed on to the third type of neuron, *motor neurons* which assist parts of the body to respond (Figure 2.2). Cheatum and Hammond (2000:40-41) point out that the PNS helps a child use the correct motor skill for a particular movement. In order for a child to write on a piece of paper, he or she must know the shape of the pencil, where to place the fingers on the pencil, how much strength to use, where to place the hand on the paper, how much force to use when writing, and which muscles to use when writing.

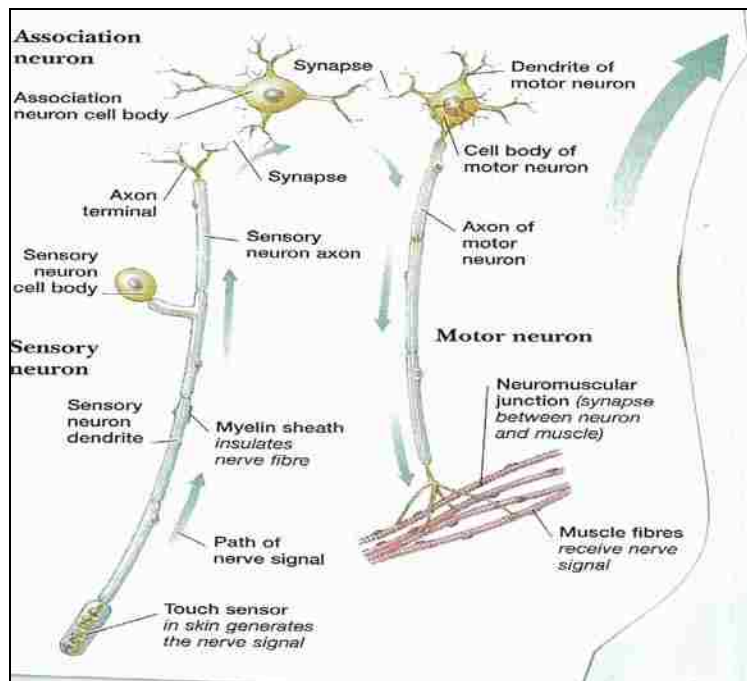


Figure 2.2: Three types of neurons

Source: Walker (2003:78)

The autonomic nervous system (ANS) forms part of the peripheral nervous system. It consists of two major systems, the sympathetic nervous system and the parasympathetic nervous system (Figure 2.3). The parasympathetic system plays a role in the daily routine aspects of bodily functioning, such as breathing, sleeping and so on. The sympathetic reacts when the body encounters a threatening situation. Its task is to protect the individual from perceived dangers, which, for example, could be, in the form of an unexpected sound, an attacking dog or too much stress. In such circumstances chemicals effect a change from parasympathetic to sympathetic control which elicits fright, usually followed by flight or fight (Kokot, 2006:30-31).

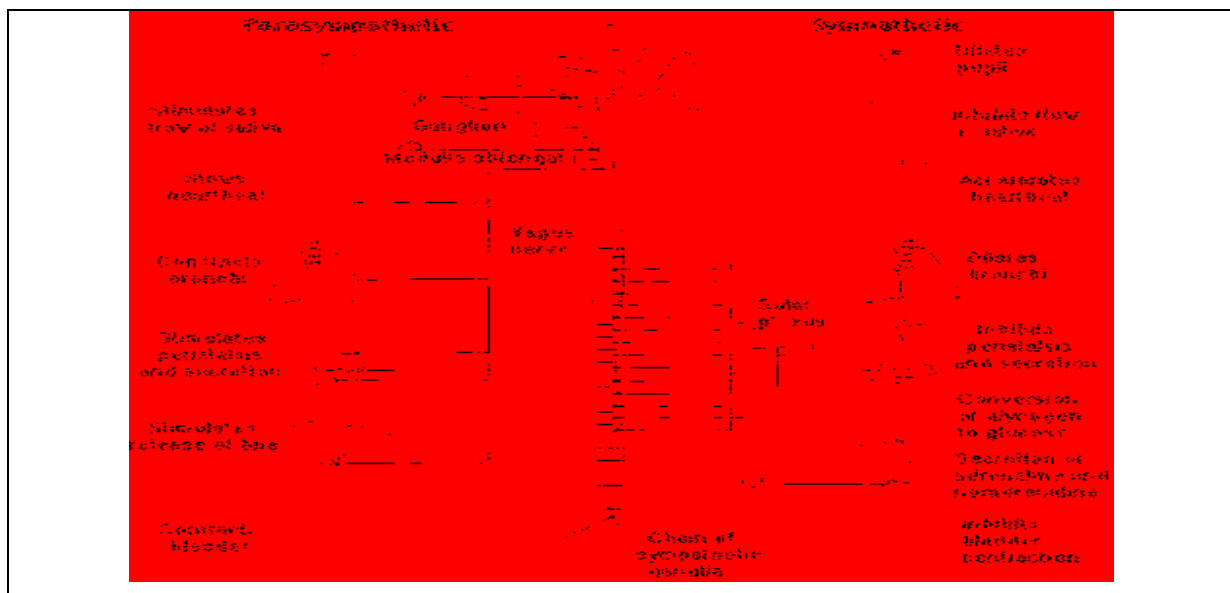


Figure 2.3: The autonomic nervous system

Source: The central nervous system (2009)

The nerve structure consists of nerve cells called *neurons*. The neurons carry tiny electrical impulses which make up a nerve message. Each neuron consists of a cell body with a nucleus and fine branches, which are called *dendrites*. The cell body has one long branch called *an axon*. Messages are received in the form of electrical impulses that are passed to the centre of the neuron. The axons have the task of carrying messages to the dendrites of the next nerve cell (Parker, 2007:68-85). The main nerves of the body consist of bundles of axons which are surrounded by *myelin sheath* (Figure 2.4). This is a fatty layer that insulates and protects the axon and helps speed up the impulses from the brain (Hall, 2005:14–15). All these components constitute the neuron system (Figure: 2.5).

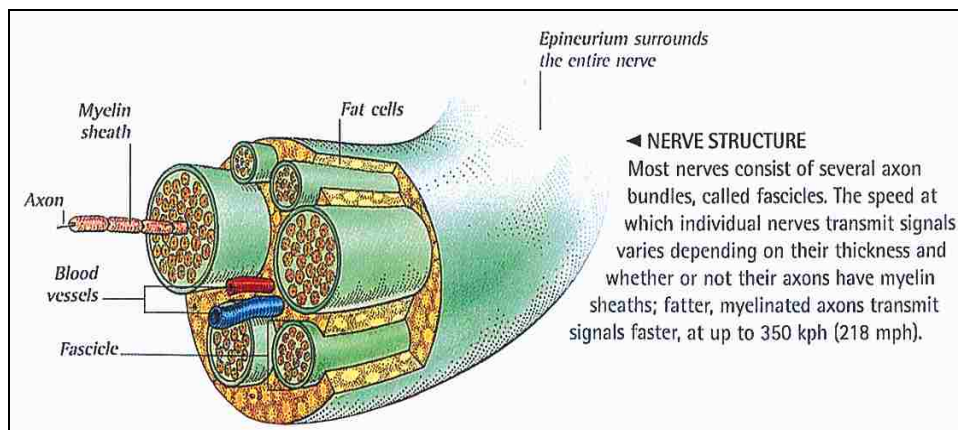


Figure 2.4: The nerve structure

Source: Walker (2003:83)

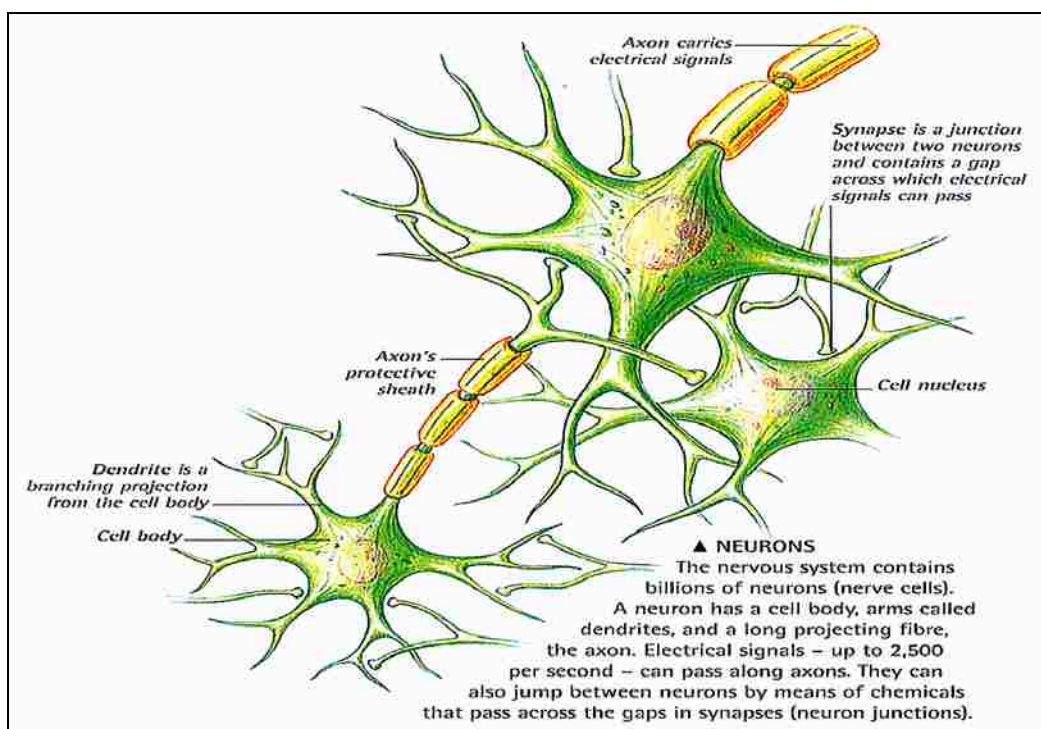


Figure 2.5: The neuron system structure

Source: Parker (2007:71)

2.2.2 Different parts of the brain involved in motor activity

The brain is the largest part of the nervous system and undoubtedly the most complex organ in the body. As the headquarters of the nervous system, the brain contains billions of interconnecting neurons. It regulates both the non-conscious process and coordinates most voluntary movements. Being the site of consciousness it allows humans to think and learn (Parker, 2007:74-75). Different parts of the brain perform different tasks. Emphasis is placed on the following parts; *the cerebrum* (large brain), *middle brain* (deincephalon), *cerebellum* (little brain) and the *brain stem* (Figure 2.6).

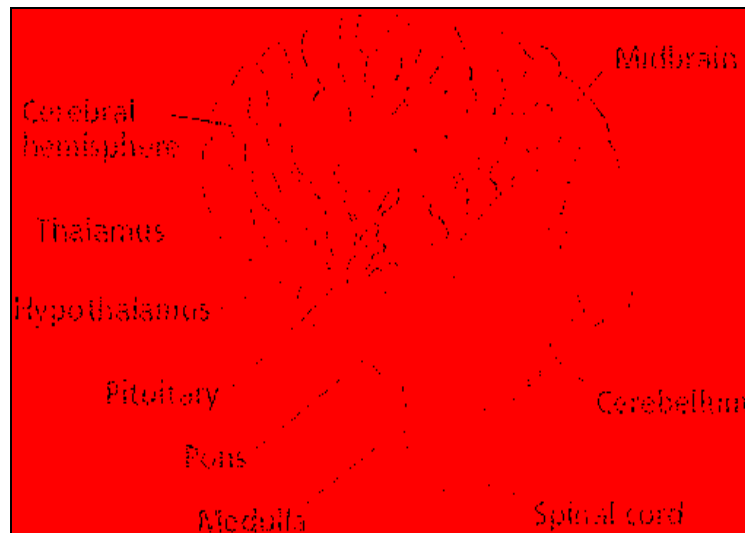


Figure 2.6: Different parts of the brain structure

Source: The nervous system (2009)

2.2.2.1 Cerebrum

The largest part of the brain is the cerebrum and makes up eighty-five percent of the brain's weight. The cerebrum overhangs the other main parts of the brain, namely the cerebellum and the brain stem. The surface of the cerebrum is covered with ridges called gyri and grooves called sulci. Parker (2007:76-77) states that cerebrum is mainly concerned with the organisation of motor information being sent to muscles to make movements smooth and coordinated. Hall (2005:40-41) points out that the outer layer of the cerebrum is called the cortex. The cerebrum is divided into two halves, called cerebral hemispheres. There are deep grooves (fissures) which run down the centre of the cerebrum dividing it into left and right hemispheres. The connecting bridge between the two halves consists of nerves fibres called the corpus callosum. Although they might look alike, they do very different things.

The left hemisphere controls mainly the right side of the body and the right hemisphere controls the left side of the body. One of the tasks of the left hemisphere is the controlling of the written and spoken languages, numbers and problem solving. The right hemisphere deals with the appreciation of art and music as well as the recognition of faces (Walker, 2003:88-93). The complexity of the brain is outstanding. The two hemispheres give the brain the ability to process and store information not excluding their ability to initiate deliberate movements that the body makes. These various tasks are carried out by the *grey matter* which forms the surface or the cortex of the cerebral hemispheres of the

brain. *The white matter* is below that and consists of the axons, the brain's 'wiring', which carries signals to and from other parts of the body. Looking at the cerebral cortex a variety of cerebral activity has been researched. Some parts deal with incoming information from the senses while others trigger movement. A third area, the association cortex, deals with the interpretation and analysis of information. It is also involved in learning, planning and memory (Walker, 2003:88-89).

A detailed summary of the areas of the cortex as well as the activity is briefly mentioned below:

- Premotor cortex: this area coordinates complex movements such as throwing a ball.
- Motor cortex: triggers individual muscles into action.
- Prefrontal cortex: is involved in abstract thought including problem solving and planning.
- Broca's area: produces speech.
- Primary auditory cortex: receives signals from the ears.
- Auditory association cortex: perceives patterns in sound and identifies sound sources.
- Primary somatic sensory cortex: receives signals from sensory receptors in the skin.
- Somatic sensory association cortex: interprets sensations from the skin and also stores these sensations as memories.
- Wernicke's area: interprets spoken and written language.
- Visual association cortex: analyses patterns in visual information comparing it with visuals that have been seen before to form "images".
- Primary visual cortex: this area receives incoming signals from the eyes and interprets shapes, colour and movement (Parker, 2007:86).

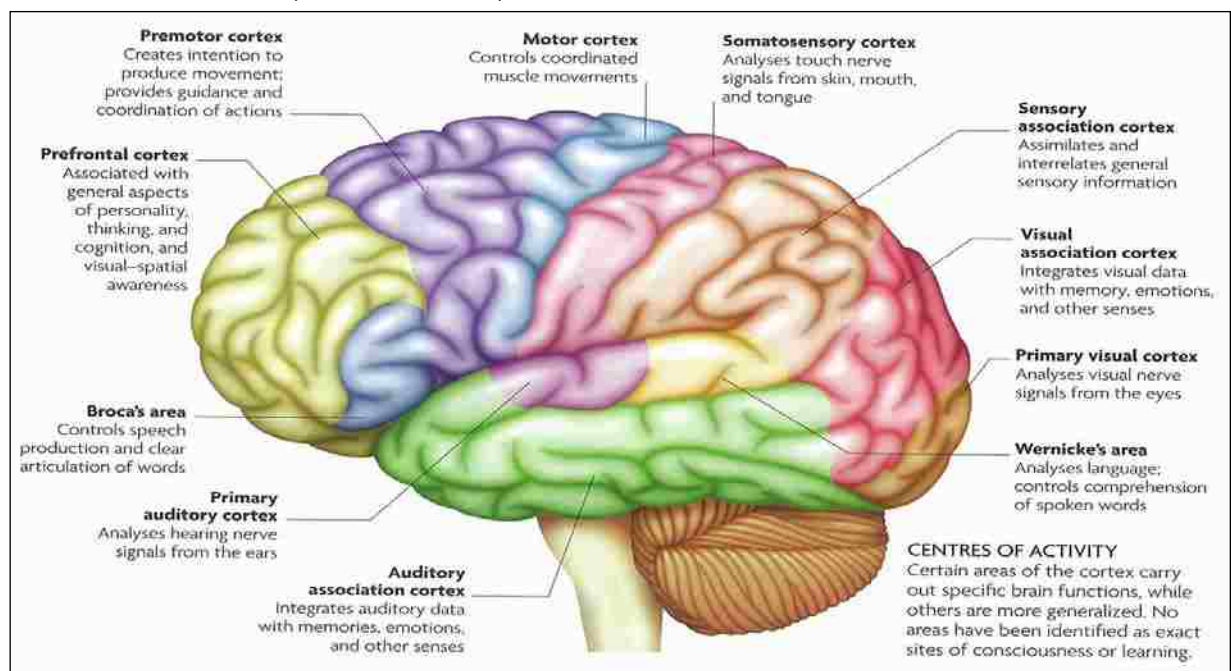


Figure 2.7: Functions of the cerebral cortex structure

Source: Parker (2007:86)

Further research has indicated that the cerebrum consists of four outer lobes (Figure 2.8). These four main lobes according to Hannaford (2005:83), Hall (2005:42-43), Nel (1999:34-35), Levine & Clutch (2009:1-3) and Parker (2007:74-78) have general functions which are of importance:

- **Frontal lobe:** This particular lobe (primary motor area) is situated right behind the forehead and is the “orchestra leader” of the brain. The back section of the frontal lobe is known as the motor cortex which works closely with the other parts of the brain to ensure muscles move smoothly and accurately. This lobe is concerned with learned motor activities of complex and sequential nature. It is also responsible for speech production, general intellect, the initiation of motor control and aspects of “personality” are based in this lobe.
- **Parietal lobe:** This lobe is located behind the frontal lobe and contains the sensory cortex. This area controls general sensory intake (information from the eyes, ears, skin and nose) and the interpretation thereof. The interpretation is in the region called the somatosensory cortex.
- **Occipital lobe:** The lobe is situated just behind the parietal lobe and controls visual intake and the interpretation thereof. The primary visual area deals with the receiving of sensory impulses from eyes, interprets shape, colour and movements while the visual association area deals with present visual experiences, recognition and evaluation of that which is seen.
- **Temporal lobe:** This lobe is located under the parietal lobe. Its task is the recognition of sounds, their tone and loudness (information from ears) and this lobe also plays a part in the storage of memory.

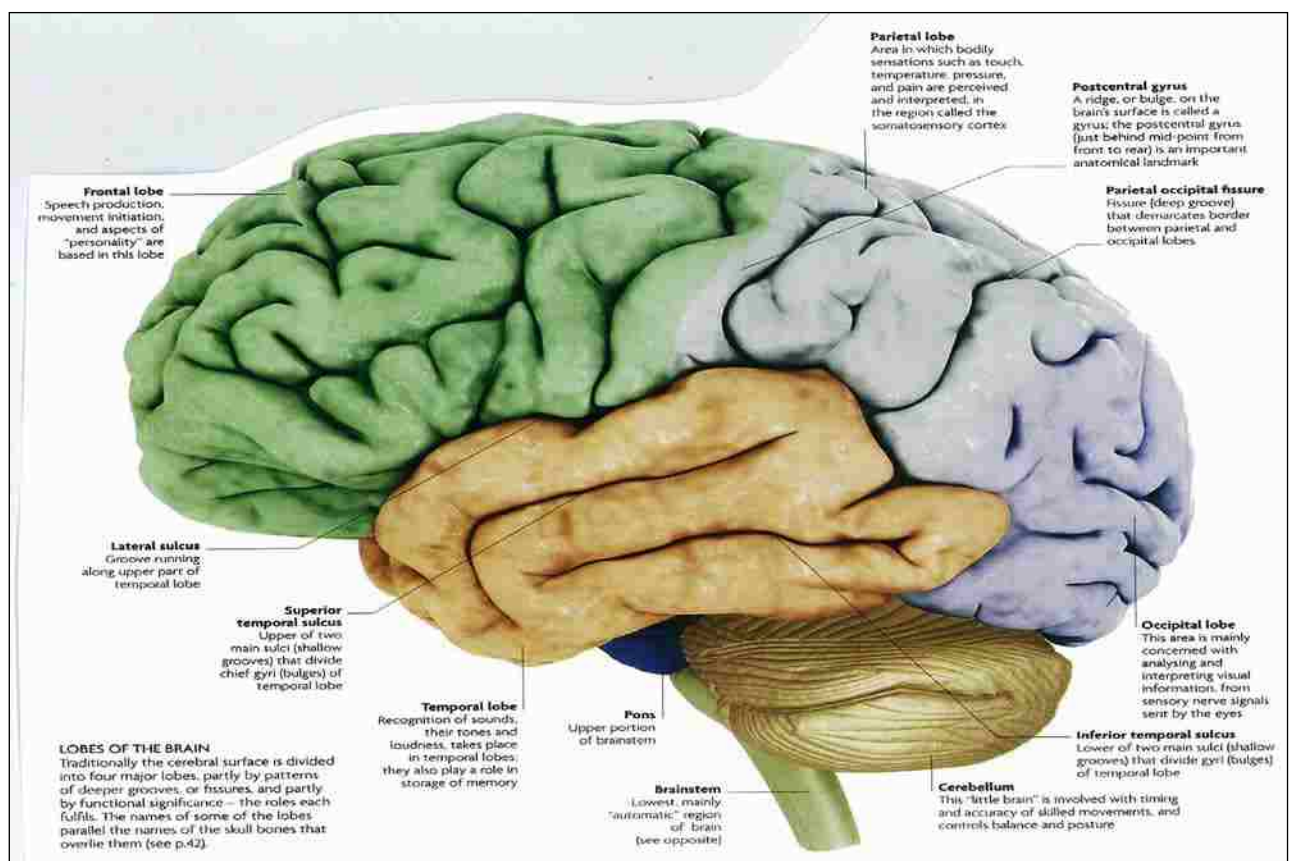


Figure 2.8: The lobes of the brain structure

Source: Parker (2007:76)

2.2.2.2 The middle brain (diencephalon)

This particular part of the brain surrounds the *thalamus* (sensory integration centre) and the hypothalamus which are deep inside the brain. The function of the thalamus is to regulate the sensory intake to the conscious brain which is very important for motor control. The thalamus is a major relay station that monitors and processes incoming information before it is sent to the upper regions of the brain (Parker, 2007:74-76). The *hypothalamus* which is situated under the thalamus has the task of regulating the homeostasis that controls the inner processes of the body, for example the autonomic nervous system, body temperature, blood pressure, emotions, food intake, thirst and sleep-awake cycle (Parker, 2007:78-79; Levine & Clutch, 2009:1-3).

2.2.2.3 The cerebellum

The *cerebellum* (also known as the “little brain”) is the second largest part of the brain which is situated at the rear of the brain. The cerebellum resembles a butterfly with folded wings and it has a central region and two cerebellar hemispheres, one on each side. The cerebellum is responsible for the control of fine motor coordination and body movement, posture, muscle tone and balance (Hall, 2005:41; Macnair, 2005:118; Parker, 2007:76).

The role of the cerebellum in motor control is extremely important. Researchers have shown how successful they have been using the relationship between the cerebellum and motor activity in therapy (Bluestone, 2000; Goddard, 2002; Kokot, 2006). Numerous pathways link the cerebellum with the motor cortex and provide information on the feedback on the position of the body in space (proprioception). These pathways send information to the muscles resulting in movement. The constant feedback on the body position is used to fine-tune motor movements (Van der Westhuizen, 2007:93).

2.2.2.4 The brain stem

The third part of the brain is the *brain stem* which connects the brain to the spinal cord (Figure 2.9). It consists of the medulla oblongata, the pons and midbrain, and it extends downwards to merge with the spinal cord (Hall, 2005:40-41). All sensory and motor nerves run through the brain stem and transport information between the brain and spinal cord. It automatically regulates control over the respiratory and cardiovascular systems. The brain stem is responsible for coordination of muscle functions, maintaining muscle tone and determining consciousness (Walker, 2003:88-89; Hall, 2005:42-43).

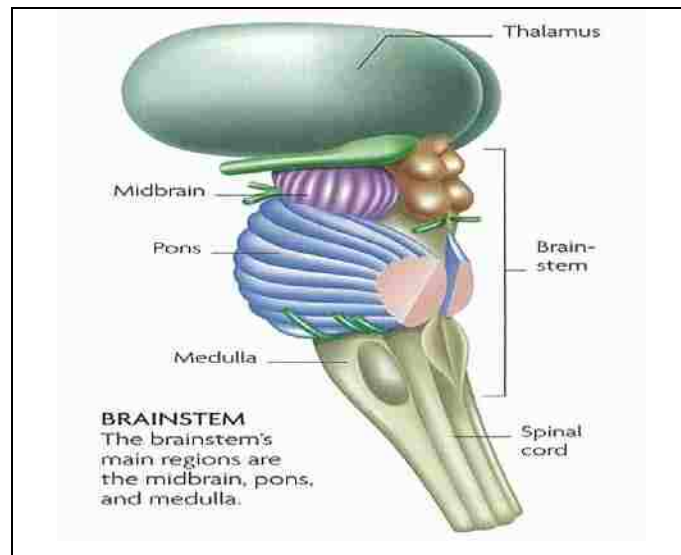


Figure 2.9: The brain stem structure

Source: Parker (2007:77)

2.2.2.5 The spinal cord

The spinal cord runs along the dorsal side of the body and links the brain to the rest of the body. It regulates the two directional nerve impulses. These sensory fibres carry neural signals from the sensory receptors in the muscles and joints to the central nervous system. Motor fibres are carried from the brain and spinal cord to the organs and glands in the body (Walker, 2003: 88-89).

2.2.2.6 Conclusion

The researcher has come to the conclusion that the brain is an amazing organ. It has to organise its billions of individual nerve cells into efficient systems to sense, process, perceive, store and act on the continuous stimulations of visuals, sounds, tastes, smells and touch in the environment. In its simplest form, the human organism can be considered a “sensory-integrative-motor-sensory-feedback-system”. It is a system of sensory input, integration and motor output. The output is a result of the process of organising, or integrating, sensory stimuli for use (Karp & DePauw, 1989:77; Liddle & Yorke: 2004:5-6). The process is ongoing and continuous and is discussed in the ensuing section.

2.3 THE SENSORY SYSTEM

The emphasis of the development of healthy sensory systems cannot be ignored as it is crucial to developing learning readiness. Kokot (2006:51) states that children who experience trouble with their sensory systems also usually have one or more developmental problems or delays which impact their academic achievements.

The sensory system is an interrelated system without which the body cannot function. Sensory awareness is learnt very early in life and an understanding of the sensory system as it relates to movement is of importance for this study. The sensory system (vestibular, proprioception, tactile, visual and auditory) along with gustatory (taste) and olfactory (smell) form the full complement of ways through

which information can reach the CNS. The development of the sensory system (Figure 2.10) is hierarchical in nature. The first systems to develop are the vestibular, proprioceptive, and tactile system (earlier-maturing sensory system). At birth the mentioned systems are almost completely mature and functional whereas the visual and auditory systems (later-maturing systems) are not as mature. The later-maturing systems are interdependent on the earlier-maturing systems (Seaman, DePauw, Morton & Omoto, 2003: 50).

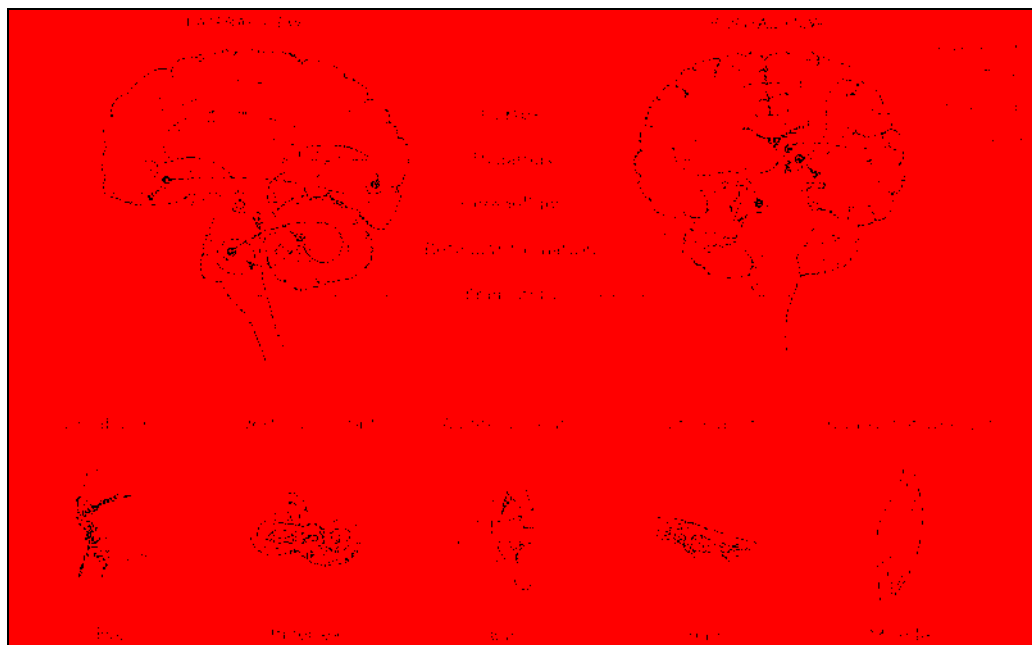


Figure 2.10: The five sensory systems structure

Source: Seaman et al. (2003:50)

Kokot (2006:51) points out that a child does not just start to use his or her sensory systems at birth. Some start developing after conception and the foetus develops the ability to hear, see, smell, taste, touch and move during the prenatal period. By the time the child is born it can be considered to be in a state of sensory readiness – ready to learn and to seek information from the environment (external stimulus) and the movement of his or her body (internal stimulus). The five sensory systems which form the very cornerstone of the child’s physical development are discussed in the section.

2.3.1 The vestibular system

The vestibular system (Figure:2.11) which is situated in the inner ear, starts developing nine weeks after conception. This system is the very first system in the body to have its nerve pathways myelinated. Myelination refers to the layers of insulation which forms a protective sheath around nerve axons which facilitates rapid and efficient conduction of impulses. The myelination of the vestibular system begins at 16 weeks of gestation and by 20 weeks after conception it is completed. This provides the foetus with a sense of direction and orientation in the womb as well as to help the child cope with gravity once he or

she is born. The result is that before a child enters the world he or she should have an efficiently functioning vestibular system (Goddard, 2002:56-58; Kokot, 2006:5-7).

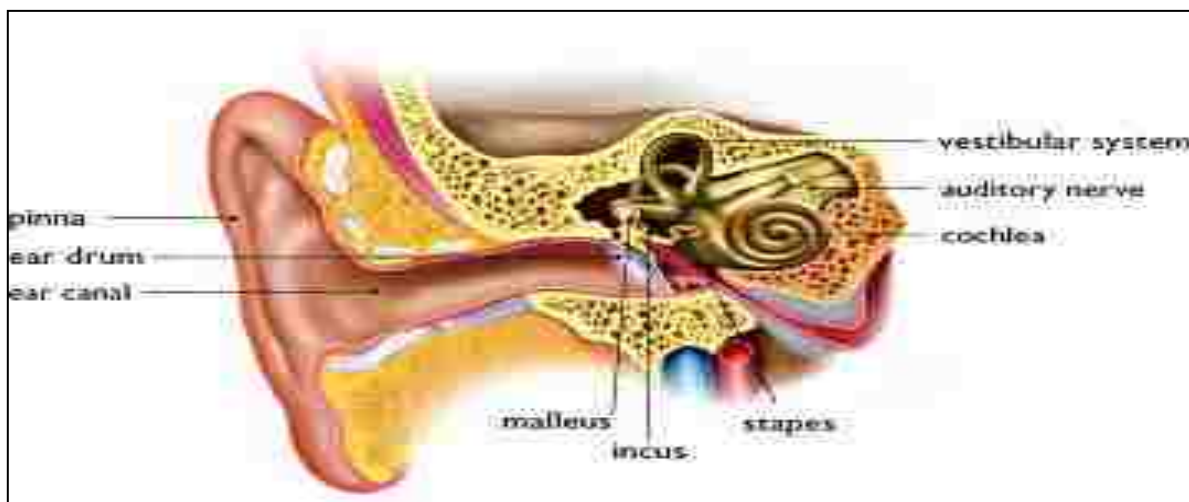


Figure 2.11: The vestibular system structure

Source: How we hear - Journey to cochlear implants (2009)

The vestibular system is considered to have the most important influence on other sensory systems and on the child's ability to function in everyday life. According to Seaman et al. (2003:51) and Kokot (2006:53-55), the vestibular system provides widespread influence throughout the CNS and contributes to coordination and timing of all sensory input for enhancement of perception and physical development.

The receptors making up the vestibular system are the three semicircular canals and the vestibule (utricle and saccule) which are situated in the inner ear (Figure 2.12). The canals are shaped like tunnels, with one end of the canal opening into the utricle and the other into the ampulla. There is a gelatine-like mass that contains hair cells at the connection between the ampulla and the semicircular canals. Movement of the head stimulates the fluid inside the canals, which causes the hair cells to be stimulated. The movement induces a chemical reaction which causes an electrical charge to be transmitted to the brain via the nerve fibre (Figure 2.13) (Cheatum & Hammond, 2000:145-149; Winston, 2004:124; Hannaford, 2005:38-39).

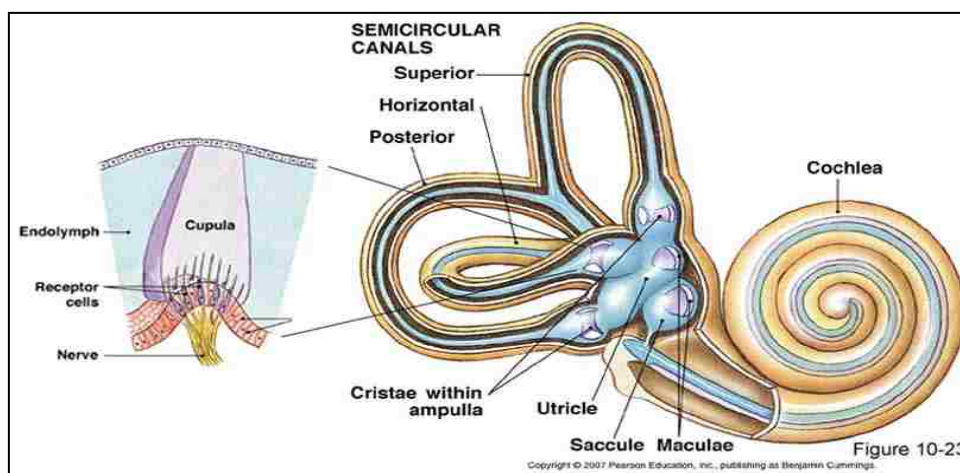


Figure 2.12: The semicircular canals structure

Source: Sensory Processing Dysfunction – Vestibular Activation (2009)

The semicircular canals, utricle and saccule are often referred to as the balance sense organs. The overall function of the vestibular system is to communicate a sense of where the body is in space and to maintain posture and balance that is required of the individual to be able to perform motor activities. The vestibular receptors provide information to an individual whether one is moving fast or slow, if one is maintaining balance against the pull of gravity, whether one is moving or the room is moving, whether one's head is rotating, the body is bending or remaining static. It also helps the child know if he or she is sitting upright or falling off the chair (Cheatum & Hammond, 2000:145-149; Winston 2004:127; Kranowitz, 2005:24).

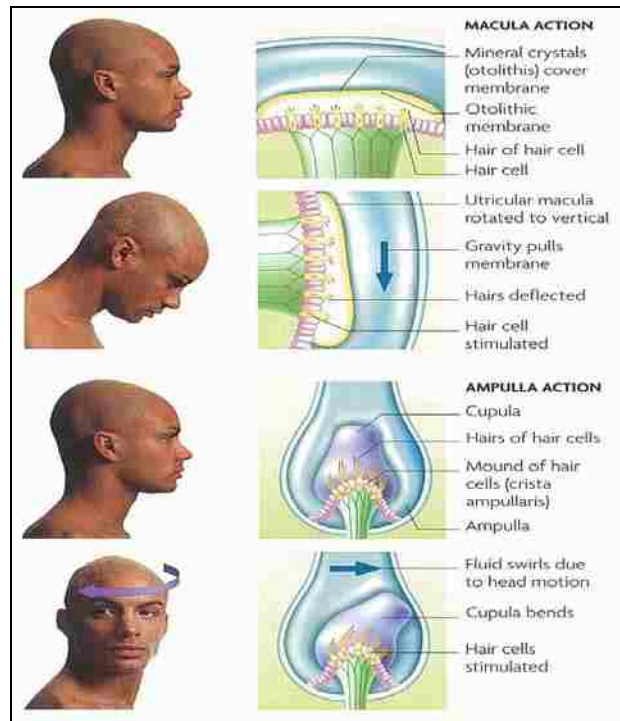


Figure: 2. 13: The vestibular receptors structure

Source: Parker (2007:91)

Problems in the balance system will have repercussions for all other areas of functioning such as muscle tone, ocular muscle control and proprioceptive control. These problems affect the sensory motor systems, because all the sensations pass through the vestibular system at brainstem level before they are transmitted elsewhere in the brain for analysis (Goddard, 2002:56; Kranowitz, 2005:56-57).

Muscle tone is controlled by the vestibular system and it is considered to be the amount of tension normally visible when the muscles are in a resting state. Muscle tone is required to control posture which includes the strength needed to sit in a chair, trying to hold the neck steady for reading and writing, or to compete in sport or recreational activities. According to Kokot (2006:56), it is often taken for granted that the child has automatic control of the skeletal muscles in order to sit or stand still. Other requirements a child needs are to be able to stabilise the body to move an arm, leg, hand or foot

independently during fine and gross motor activities. The vestibular system and the reflex system are closely aligned with the visual system. They act as a foundation upon which the ocular-motor and visual perceptual skills are based. Pyfer in Goddard (2002:59) acknowledges the impact of the proper functioning of the vestibular system on motor development as follows:

Vestibular input is necessary for static and dynamic balance development, eye tracking ability and motor planning, children who are slow to develop good vestibular functioning are delayed in all gross motor patterns which require coordination of both sides of the body. They have difficulty in maintaining posture, with eye-hand coordination and with fine motor control.

The valuable role the vestibular system has to play in the human body is summarised below (Cheatum & Hammond, 2000; Kranowitz, 2005:115-116; Goddard, 2002:56-58; Williamson & Anzalone, 2001:7-9). It:

- Is the unifying system in the brain that modifies and coordinates information received from the visual, proprioceptive, auditory and tactile systems.
- It primes the entire nervous system to function effectively.
- Functions like a traffic cop telling each stimulus where and when it should go and stop.
- Informs the nervous system where it is in relation to the pull of gravity in order for the person to maintain equilibrium and has a strong influence on muscles that control posture and muscle tone.
- Helps us know if we are upright, upside down or lying down (in combination with the proprioceptive and visual systems)
- Influences ocular-motor control (e.g. controlling eye movements to maintain a stable visual field when moving).
- Regulates muscle tone and coordination (i.e., modifies the readiness of muscles to act).
- Tells us if we are moving or still, slowing down or speeding up.
- Provides information for controlled movements- rolling over, crawling, sitting still, standing, moving through space or performing sports skills.

2.3.2 The proprioceptive system

Kranowitz (2005: 136-139) notes that proprio means 'one's own' in Latin. It is the body's 'internal eyes' which give information regarding, where the body is or body parts are in space, how our body parts relate to one another, how much and how quickly our muscles are stretching, how fast our body is moving through space, how our timing is, and how much force our muscles put forth.

Hannaford (2005:48) describes proprioception as the body's sense of itself in space, it is one of our most important ways of knowing. All the muscles have proprioceptive receptors, which inform the body about its physical position and provide feedback necessary for a person to move and maintain balance.

Cheatum and Hammond (2000:185) add that proprioceptive refers to the actual awareness of sensations that come from receptors in the muscles, joints, skin, tendons, and underlying, tissue. Seaman et al. (2003:50) elaborate by stating that the proprioceptive system detects pressure and vibration such as pushing, pulling or squeezing. This system has tremendous importance to motor development in that it is critical to the motor action of reflexes, automatic responses, and planned movement.

Williamson and Anzalone (2001:9) state that the proprioception is the position sense – continuous internal awareness of the posture of the body. It could be defined as the body's positioning system. Further, it is also seen as movement sense, the awareness of when a part of the body is in motion. To summarise, the functioning and role of the proprioceptive system is as follows (Cheatum & Hammond, 2000:185-194; Williamson & Anzalone, 2001: 8-9; Hannaford, 2005:49-51; Kranowitz, 2005:136-139):

- The term proprioception applies to the actual awareness of sensations that come from receptors in the muscles, joints, skin, tendons, and underlying tissue i.e. from within the body. All this information is sent to the brain.
- Together with the vestibular and visual systems the proprioceptive system gives us constant information about what is happening to the body and where the body is in terms of the three-dimensional space in which we exist. The interaction between the two systems helps keep the body upright and balanced.
- The proprioceptive system plays a key role in helping a child maintain equilibrium, progress through the motor-development stages, and later perform complex motor skills.
- Proprioception is necessary for the development of body schema. Body schema evolves through neuromuscular information which is sent to the CNS during static and dynamic movements. A child's body schema is an internal awareness, or map, of the relationship of the body and body parts to each other. Without body schema there is little hope that the child can progress through the developmental stages of laterality, directionality and directional discrimination.
- The proprioceptive system is closely connected to both the tactile and the vestibular systems. It helps to integrate touch and movement sensation.
- Information from the proprioceptive system helps the child to determine how much force is required when reaching for a pencil, writing, drawing or sitting on a chair.
- Motor planning is the ability to plan, organise and complete a series of movements that are directed toward some purpose. It must occur before the development of motor skills or purposeful action.

2.3.3 The tactile system

Cheatum and Hammond (2000:224-226) explain that the tactile system is one of the very first sensory systems to develop in the baby as early as seven weeks in utero. The sense of touch provides the child with the first source of contact with the outer world. The area in the brain which perceives touch is called the somatosensory cortex. A newborn child's tactile system responds with more of a defensive reaction

as a survival mechanism. Areas, which have the greatest sensitivity to touch, are in the mouth, lips, tongue, fingers and the hands.

This system enables children to help discriminate and orientate to the environment, so that they know that they are touching and what texture the objects or surfaces consists of. The child's skin sends information to the brain regarding touch, pain, temperature, and pressure. According to Goddard (2002:60-61), the tactile system succeeds in providing neurological information, which establishes a map in the brain regarding the body parts which leads to the formation of the child's body schema.

Hannaford (2005:44-45) states that the skin is the largest organ of the body which is equipped with nerve sensors for light, touch, pressure, heat, cold, pain and proprioception. According to Kranowitz (2005:320), the tactile system receives sensations of pressure, vibration, movement, temperature, and pain primarily through receptors in the skin and hair.

Seaman et al. (2005:51) describe this system as the touch-pressure or tactile-touch system. It receives stimuli from the receptors beneath the skin. They go on to divide the tactile system into two levels namely touch and tactile. Touch refers to the primary sense, characterised by the reception of non-discrimination, non-localised and generalised information. Tactile is a later developing sense which enables one to discriminate between and localise tactile stimuli.

The responsibility of the tactile system is to help the child to tell the difference between the moisture of the skin and the texture, shape, size, weight of objects when held in the hands. It allows the child to determine if clothing is comfortable, scratchy, or tight, light or heavy. The child is also able to distinguish if something is uncomfortable or whether he or she enjoys people standing close or not, in other words, if their touch is pleasant or not. Children are also to indicate where on the body they have been touched (location of touch) (Cheatum & Hammond, 2000: 225-227).

As the children mature, the tactile system is more prominent. They learn to discriminate between light, cold, or rough which could be more alerting while, heavy, deep, warm or soft is more calming. The child's reaction to touch could be one of flight or fight. A child may thus be either *insensitive* to touch or *oversensitive* to touch. Insensitivity may lead to an inability to localise touch on the body, to be insensitive to pain and insensitive to temperature. Children who are highly sensitive to touch are referred to as having *tactile defensiveness*. These children perceive touch as irritating and painful. These children feel uncomfortable in their bodies and tend to move a lot (Kranowitz, 2005:85; Cheatum & Hammond, 2000:227-230; Goddard, 2002:60-62).

2.3.4 The auditory system

This system is the hearing sense, which receives stimuli through the ear. We are born with the basic skill of hearing. We cannot learn how to hear, either we hear or we do not. This system develops in

tandem with the vestibular system in utero. It connects with muscles throughout the body helping it to regulate, equilibrium and coordination (Kranowitz, 2005:176).

According to Van der Westhuizen (2007:173), the auditory system helps control balance, body movement and coordination. A large amount of the sensory messages received by the brain are received via the ears. The ears also play a part in helping to control the eyes when one reads and one's arm, hand and fingers when one writes. Kranowitz (2005:176) explains that the vestibular and the auditory systems both work together as they process sensations of movement and sound. Their intertwinement is because they both begin to be processed by the hair cells situated in the receptors of the ear. Seaman et al. (2003:51-52) agrees that auditory system is also closely linked to the vestibular system due to their close proximity to one another within the inner ear. They also share the same cranial nerve (vestibulo-cochlear).

Kranowitz (2005:178-177) acknowledges the profound influence of the ear on the physical development. Not only is it vital for hearing, balance and flexibility but also for bilateral coordination, breathing, speaking, vision, social relationships as well as academic learning.

2.3.5 The visual system

The visual system is at the lower neurological level. According to Seaman et al. (2003:52), it is responsible for processing stimuli received through the eyes and requires light stimulation in order to develop and to ensure the maturation of vision through myelination of the optic nerve.

According to Van der Westhuizen (2007:161), this system is still very immature at the time of birth. Shortly after birth the visual senses start to develop dramatically as a result of the rapid wiring of the neurons in the visual cortex. Primary visual abilities develop by six months of age. These include depth perception, fine acuity, colour vision, and well controlled eye movements. The visual system is almost fully functional by one year.

Vision is a complex and the most dominant sensory system for learning more about where we are and what is happening around us. Visual perception is not eyesight and a child can either see or not see. Vision has to be developed by integrating the senses. Kranowitz (2005:156) points out that vision is developed through movement. Movement is the basis of all learning, it teaches the eyes to make sense of sights, whereas a child sitting in front of the computer or sitting still to read is not developing vision.

Children use their eyes to guide them in almost every action they take eg crawling, walking, eating, looking at picture books, playing and participating in motor skill development. Vision (visual perception) is a learned process that involves processing the images that have been gained through acuity into useful information. Children need complex visual perception in order to read. They must link the letters and words they see with how they sound and what they represent (Goddard, 2002:58-59).

Images gained through the eyes, depend on a pathway known as the vestibular-ocular-reflex arc (VOR). The purpose of the VOR is to combine images received from the eyes with information received from the rest of the sensory systems. Interference with the sensory information from the vestibular system reduces functioning of the VOR and results in distorted vision (Goddard, 2002:58-59).

Kranowitz (2005:156) explains the link between the vestibular and proprioceptive systems as having a profound influence on vision. While sitting, standing on two feet, or lying down sensations bombard the brain and facilitate eye movements. If we move around, switch directions, or change our body, head or eye position, our visual skills are strengthened. Engaging in purposeful activities helps the eyes to become coordinated. Movement, balance, muscle control, and postural responses are core ingredients for proper vision development.

Goddard (2002:70) and Delacato (1970:61) agree that the visual system as being important for academic learning as the skills for reading, writing, spelling and arithmetic are all dependent on the ability to see written symbols. Visual perception thus depends on several visual skills which are indicated below.

- *Binocular fusion* is the ability to sweep the eyes together in a coordinated way. The visual system has to blend the images received from the two eyes into a single image. Each eye has a different visual field which overlap somewhat. The brain gathers the information from each eye and changes it into a single visual image (Cheatum & Hammond, 2000:267; Kokot, 2006:72).
- *Accommodation* refers to convergence (near point) and divergence (far point). Convergence is when you focus on an object near your face or moving it closer to your face. Divergence, on the other hand, is focusing on an object at a distance or as it moves away from the face. In the classroom setup it is necessary for a child to be able to look at a book and then at the teacher in front of the class or at the white board (Cheatum & Hammond, 2000:267; Kokot, 2006:72).
- Ocular-motor skills (eye motor skills) includes fixation (focusing on an object), saccades (efficient movement from point A to point B) and smooth pursuits (tracking of moving object) (Cheatum & Hammond, 2000:267)
- Visual pursuit is used for reading a line in a book. The child should also be able to follow the teacher moving in the classroom, follow a ball being thrown towards him or her, or track the mathematic formulas on a page (Cheatum & Hammond, 2000:267)
- Depth perception refers to being able to distinguish between background and foreground.
- Adjusting in the light and dark.
- Acuity is the ability to see details of an object (Kranowitz, 2005:158-159; Cheatum & Hammond, 2000:266-267).

All senses are required in order to develop vision. The tactile sense has a huge effect on vision, for example a child sees a ball, picks it up and holds it with both hands. The following day he or she sees another ball and knows its round, smooth and solid. This information builds visual images in the brain.

Auditory senses affect vision in the same way. On hearing the door slam, the child will turn in the direction and see the source of the sound (Kranowitz, 2005:156-157).

The complexity of the visual system is such that it also requires various parts of the brain to function effectively in order to be efficient. The sections of the brain responsible for the various functioning of the visual system are illustrated in Figure 2.14.

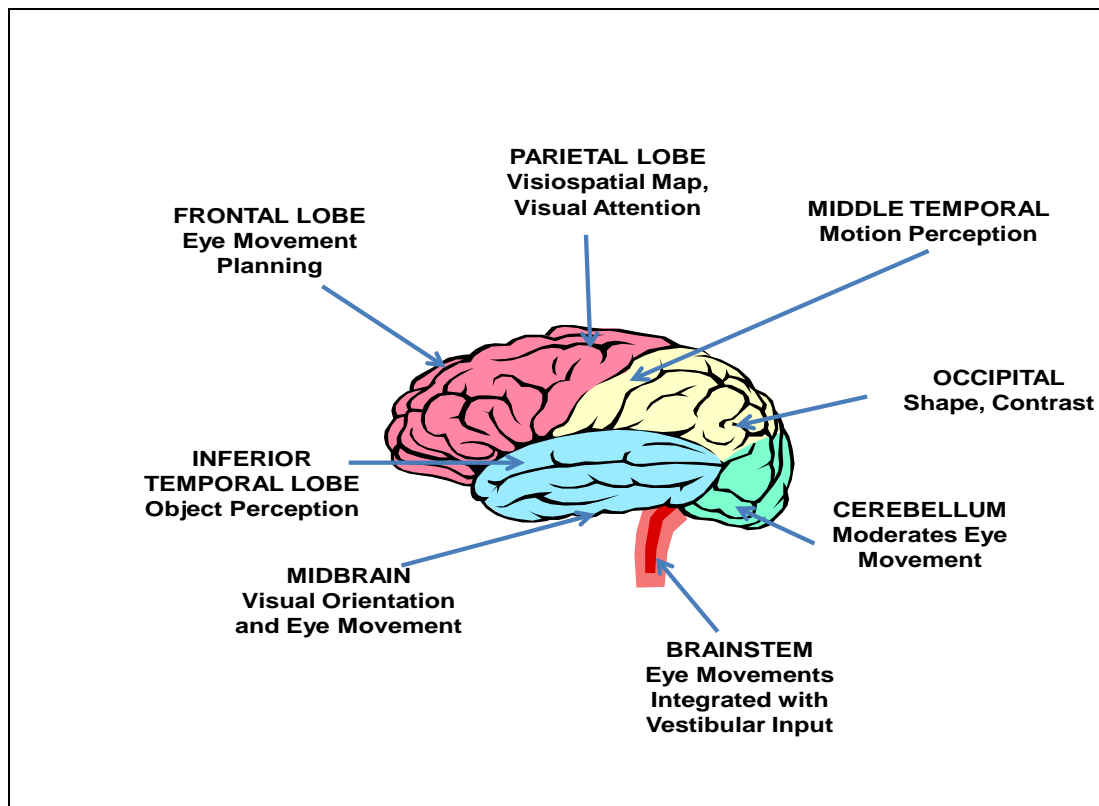


Figure 2.14: Brain parts responsible for visual functioning

Source: Hager (2006b:2)

2.3.6 Conclusion

It is clear that the human nervous system develops through use and that every child must be provided the opportunity to use these particular senses. The input senses (vestibular, proprioception, visual, auditory and tactile) are developed in their own particular sequence and is of particular importance to the development of the brain. These senses form the basis of the output channels, namely, that of mobility, speech and hand use (Delacato, 1970:56-57).

2.4 THE REFLEX SYSTEM

All essential movements made by a newborn are actually reflexes. Motor development occurs as the child gains control over the movement of his or her body. No one is born coordinated; the reason being that coordination develops through three basic levels. According to O'Dell and Cook (1997:13-16), the

reflex level provides the foundation for all motor development. Reflex development occurs first followed by gross motor and then fine motor development.

In this study it is therefore imperative to include research surrounding reflexes. Reflexes are considered to be the initiators of movement patterns during early childhood development and form an integral part of growth and development. Reflexes uphold the basic skills required for learning and are considered activities which are used to map general neurodevelopment. Reflexes are voluntary movements that are sometimes spontaneous and occur as part of the baby's usual activity. Others are responses to certain actions, while medical practitioners use reflexes to help identify normal brain and nerve activity (Kuther, 2000:1). Researchers Goddard (2002) and O'Dell and Cook (1997) consider reflexes to play an important part in learning readiness. O'Dell and Cook (1997) conducted extensive research on the Symmetric Tonic Neck Reflex and their findings reinforced their convictions that academic success is significantly based on early motor development.

A valuable contribution to research regarding reflexes, learning and behaviour in the development of the child was conducted by Sally Goddard which appears in her publication: "Reflexes, learning and behaviour, A Window into the Child's Mind" (Goddard, 2002). It was a privilege for me to attend one of Goddard's workshops in Chester during June 2007 regarding the role of reflexes and the influence on the child and learning. As participants we were provided with a test battery to assess children with possible retained reflexes, together with a movement programme which has proven to be successful to help overcome retained reflexes.

2.4.1 The importance of reflexes during early childhood development

In utero the child is protected and cushioned from the outside world. The child receives blood and oxygen from the mother but once born the child exchanges this world of equilibrium for one of chaos. The newborn then has to fend for him or herself and in order to survive, he or she is equipped with a set of reflexes designed to insure immediate response (Goddard, 2002:1). The newborn infant survives because he or she roots, sucks, swallows, breathes, cries, coughs, sneezes and eliminates body waste reflexively while he or she moves the arms, legs and head in reflex response (O'Dell & Cook, 1997:16).

The first movements in utero and up to the age of three months old are characterised as a succession of reflexes. Children are born with approximately a hundred reflexes, of which some are lost in the womb in order to make way for new reflex patterns. Primitive reflexes are responsible for the majority of the movement patterns during the child's first few months. Most of the primitive reflexes are necessary for survival. These primitive reflexes are required before they can progress to sitting, creeping, crawling, walking and running. In order for the child to progress to skilled movements, the primitive reflexes have to disappear or become integrated (Cheatum & Hammond, 2000:59-60).

Normal development depends on the emergence, inhibition and the transformation of primitive reflexes in order for postural reflexes to be released. The release of postural reflexes prepares a child for

progressive development. During the first 24 months a child gains independent movements and passes through a series of reflexes which gradually improve the ability to control his or her body. The child interacts with the environment and progresses through the series of primitive reflexes, postural reactions, and voluntary movements (Goddard, 2002:8; Cheatum & Hammond, 2000:59-60).

Primitive reflexes emerge in utero, are present at birth, and should be inhibited by 6 months of age – 12 months at the latest. The combined knowledge of reflex chronology and normal child development will help to predict which later motor skills may be impaired as a direct result of retained primitive reflexes. The aberrant reflexes can offer clues as to what is actively hindering later motor skills which subsequently will have an effect on learning readiness (Kokot, 2006:11-13).

2.4.2 Significance of aberrant reflexes for a child's ability to learn to attend, read and write

Every child is born with a set of reflexes which are important for his or her survival and which form the basis reflex system. The process of normal development depends on the emergence, inhibition and in certain instances, transformation of the primitive reflexes, so that postural reflexes may be released, in order to prepare the child for progressive development. Reflexes emerge in utero and should be inhibited or in certain cases transformed by a higher part of the brain. If this fails to happen, the reflexes remain aberrant and they represent a structural weakness in the CNS (Goddard, 2002:2).

A child with aberrant reflexes (reflexes still present) may show impaired functioning in specific areas. This dysfunction may be barely detectable but as the stressors become greater, the compensatory mechanisms start to break down and the weakness becomes more visible. Difficulties may be seen in the form of symptoms which range from clumsiness and ambidexterity, to learning and emotional disorders (Goddard, 2002:2-3; Kokot, 2006:12-13).

In the section to follow, the researcher attempts to look at a few reflexes which have an influence on learning readiness and movement.

2.4.2.1 Moro Reflex

The Moro reflex emerges at about 9 weeks in utero, is fully present at birth and should be inhibited at 2-4 months of life. The Moro reflex is a composite series of rapid movements made in response to sudden stimulation. It is an involuntary reaction to threat and is also referred to as a startle reflex. When responding to a loud sound, the baby throws the head, extends out the arms and legs, cries, then pulls the arms and legs back in. The Moro reflex is later replaced by an adult 'startle reflex' (Espenschade & Eckert, 1980:83; Goddard, 2002:4-7; Liddle & Yorke, 2004:9).

According to Goddard (2002:6-7), possible long term effects of a retained Moro reflex include:

- Vestibular related problems such as poor balance and coordination.

- Oculomotor and visual-perception problems: the child cannot ignore irrelevant visual material within a given visual field, so the eyes tend to be drawn to the perimeter of the shape, which could result in poor visual sense of the internal features.
- The child has poor pupillary reaction to light. The child tires easily under fluorescent lighting.
- Possible auditory confusion which results from hypersensitivity to specific sounds. It affects the auditory discrimination skills of the child and he or she is unable to shut out the background noises.
- Hypersensitivity.
- Hyper-reactivity.
- Sensory overload.
- Anxiety.
- Emotional and social immaturity.

2.4.2.2 Rooting Reflex

The Rooting reflex emerges between 24 – 28 weeks in utero, is fully present at birth and is inhibited between 3 – 4 months of life (Figure 2.15). The reflex of searching and sucking should be present in all full-term babies. These reflexes form part of the group of “grasp” reflexes which develop in utero. A light touch of the cheek or the stimulation of the edge of the mouth will cause the baby to turn the head toward the stimulus and open the mouth with extended tongue in preparation for sucking. The rooting and sucking reflexes insure that the baby turns toward the source of food and opens his or her mouth wide enough to latch on. The sucking and swallowing reflexes are vital for early feeding. The rooting reflex is at its strongest in the first couple of hours after birth, but if the baby does not receive satisfaction in his or her attempts this reflex will weaken (Goddard, 2002:13-14).

A retained oral reflex will result in continued sensitivity and immature responses to touch in the mouth area, especially the lips. Difficulty will be experienced when solid foods are introduced and the persistent suck reflex will prevent the tongue from developing the mature combination of movements necessary for swallowing. The tongue remains far forward in the mouth to allow effective chewing. Dribbling will also be the result of the retained sucking and swallowing reflex. Both the reflexes prevent the child from gaining adequate control of the muscles at the front of the mouth. Manual dexterity may also be affected because the immature sucking and swallowing continue to affect the hands, which causes involuntary palming movements to occur in time with sucking. The retained reflexes will have an affect on the development of speech. It is believed that the muscular action involved in feeding is an essential preparation for babbling and speech. Older children may have speech and articulation problems (Goddard, 2002:13-14).

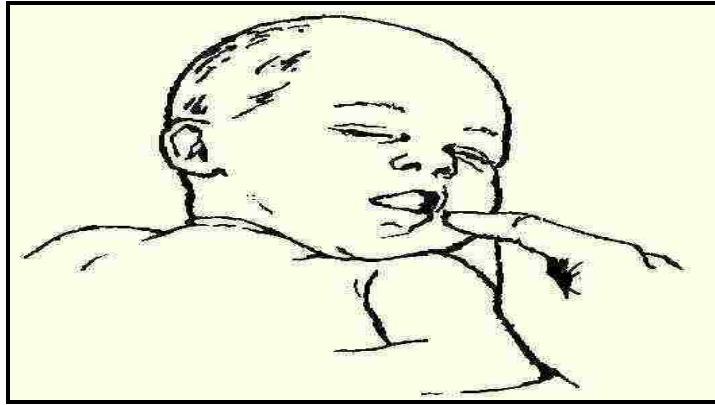


Figure 2.15: Rooting reflex
Source: Infant Reflexes (2009)

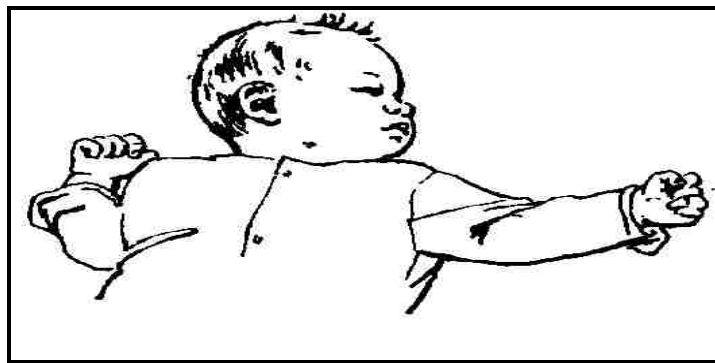


Figure 2.16: The ATNR reflex
Source: Infant Reflexes (2009)

2.4.2.3 Palmar Reflex

This reflex emerges at 11 weeks in utero is fully present at birth and should be inhibited at 2 -3 months of life. The common characteristic of the reflex is to grasp. A light touch of the palm of the hand will result in closure of the fingers. The palmar reflex can be elicited by sucking movements, and the action of sucking may cause kneading of the hands in time to sucking movements. Continuous reflex activity in this area could have a lasting affect on fine motor coordination, speech and articulation if they fail to be inhibited at the correct time (Goddard, 2002:8; Liddle & Yorke, 2004:9).

The effect of the retained reflex which connects the palms with the movements of the mouth can be seen when a child first learns to write or draw. Until these skills come easily, the child will lick the lips, or twist the mouth and the tongue could be moving over the lips that are “writing with the tongue”. Some therapists call this movement overflow (Goddard, 2002:8).

Goddard (2002:8) believes a retained Palmar reflex may cause the following:

- Poor manual dexterity, prevention of thumb and finger movements.
- Lack of “pincer” grip, will affect pencil grip when writing.
- Speech difficulties due to the relationship between hand and mouth movements.
- Palm of the hand may remain hypersensitive to tactile stimulation.
- The child will have overflow movements with the mouth when trying to write or draw.

2.4.2.4 The Asymmetrical Tonic Neck Reflex (ATNR reflex)

This reflex emerges at 18 weeks in utero is fully present at birth and is inhibited at about 6 months of life (Figure 2.16). The ATNR reflex assists and reinforces the birth process. This is maybe why children taken by Caesarean section are at higher risk for developmental delay. The ATNR ensures a free passage of air when the baby is in prone position. ATNR reflexes form the basis for later reaching movements. It helps increase extensor muscle tone, one side at a time (Goddard, 2002:10-12).

By six months the ATNR should have completed its task. The excessive retention of this reflex will interfere with the fluent cross pattern crawling on the stomach. Crawling and creeping are important for furthering the development of hand-eye coordination and the integration of vestibular information with other senses. During these processes the myelination of the central nervous system is enhanced (Goddard, 2002:10-12; Kokot, 2006:16).

Goddard (2002:11) states that aberrant reflex causes visual problems in the sense that the eyes are locked into the hands and they do not want to cross the midline. This results in the hands also not wanting to cross the midline. The “ocular pursuit” is impaired especially when the child reads, he or she may be inclined to stop in the middle of the line affecting fluency in reading. Retention of the ATNR interferes with writing as well. Every time the child looks at the pencil there is a slight extension of the arm, looking away causes the arm to flex. All this creates a back-and-forth action on the pencil, which results in poor handwriting. The child might learn to compensate by using an immature pencil grip or by using excessive pressure. The physical act of writing will always require intense concentration to the detriment of cognitive processing. Goddard (2002:10-12) identified various symptoms which suggest a retained ATNR reflex, this includes:

- Balance affected by the head movements to either side.
- Homolateral instead of normal cross pattern movements. This means the arms and the legs on the same side move together (eg when walking, marching, skipping).
- Difficulty crossing the midline (will battle when it comes to reading, stopping in the middle of the page, reading fluency across the page, losses place easily, skips words and lines; if the child favours one eye to avoid midline crossing he or she will turn head side on to read).
- Mixed laterality (using right foot, left hand and right ear).
- Poor handwriting and poor expression of ideas on paper.
- Visual-perceptual difficulties, especially in symmetrical representation of figures (Goddard, 2002:10-12; Goddard Blythe, 2006b).

2.4.2.5 Spinal Galant Reflex

This reflex emerges at 20 weeks in utero, is actively present at birth, and is inhibited at between 3 – 9 months (Figure 2.17). If a baby is placed in the prone position and stimulation of the back to one side of

the spine is applied, it will result in hip flexion (rotation) to 45 degrees toward the side of the stimulus. It should be equally strong on the other side as well. The exact function of this reflex is not known.



Figure 2.17: Spinal Galant reflex
Source: Movement and Learning (2009)

A retained spinal Galant reflex, according to Goddard (2002:16-17), is found in children who may have poor bladder control, and who continue to wet their beds after the age of five. In the classroom children with a retained spinal gallant reflex find it difficult to sit still for a long time. This child is often accused of having “ants in the pants”. The child wriggles and squirms, constantly changes body positions. The cause being the elastic of the waistband or simply the leaning against the back of the chair might trigger the reflex. The reflex will affect concentration and short term memory as the child is constantly irritated by the clothing around the waist. If the reflex remains on the one side only, it could affect the child’s posture, gait and any other form of movement. It could also cause scoliosis (abnormal curvature of the spine). Goddard (2002:16-17) states that symptoms of retained Galant reflex include:

- Fidgeting
- Bedwetting
- Poor concentration
- Poor short term memory
- Hip rotation to one side while walking

2.4.2.6 Tonic Labyrinthine Reflex

This reflex is also known as the “baby reflex”. Distinction is made between two aspects, namely:

- *The Tonic Labyrinthine reflex (forwards)*. This reflex emerges in utero, is present at birth and is inhibited at approximately 4 months of life.
- *The Tonic Labyrinthine reflex (backwards)*. This emerges at birth and is gradually inhibited from 6 weeks of age up to 3 years of age. It involves the simultaneous development of postural reflexes, symmetrical tonic neck reflex and the Landau reflex (Goddard, 2002:17-18; Kokot, 2006:18).

The Moro and the Tonic Labyrinthine reflexes are closely linked during the early years of life. Both reflexes are vestibular in origin and both are activated by the stimulation of the labyrinths and any alteration of position in space. The TLR provides the child with an early primitive method of response to the problem of gravity and exerts a tonic influence upon the distribution of muscle tone throughout the child's body. Balance, muscle tone and proprioception are all trained during the responses to gravity. A retained TLR will result in the child lacking gravitational security which will subsequently result in the child having difficulty in judging space, distance, depth and velocity.

The inhibition of the TLR at the correct time will constantly trip the vestibular in its actions and interactions with the other sensory systems. Continued tonic labyrinth reflex activity will prevent the head righting reflex from developing fully. If head righting is lacking, eye functioning will also be impaired as the eyes operate from the same brain circuit namely the vestibulo-ocular reflex arc. The malfunctioning will be twofold. Balance will be affected by the faulty visual information and vision will be affected by poor balance. The child will assume it to be normal as he or she does not know anything else (Goddard, 2002:20).

The retained tonic labyrinthine reflex will prevent the child from being able to creep on the hands and knees as the movement of the head will result in the extension of the legs. The prolonged influence of the TLR will have numerous implications, such as, balance problems, getting tired when standing for any length of (time, floppy muscle tone, fearing heights (when head goes forward, knees bend and feels he or she is falling). A child will find holding hands up for a while to be tiring (Goddard, 2002:19; Kokot, 2006:18).

Ocular motor dysfunction will cause the child's eyes to play tricks so that he or she cannot always rely on what is seen. Depth perception may be impaired and children may suffer from figure-ground effect. The child will battle readjusting eyes when looking far to near distances. Not only is the spatial perception affected but the child may also have difficulty locating sound and becomes easily disorientated. Goddard (2002:19) mentions the following symptoms of retained TLR – forwards and retained TLR -backwards:

Symptoms of retained TLR-forwards:

- Poor posture – stoops
- Hypotonus (weak muscle tone)
- Vestibular related problems – poor sense of balance & car sickness
- Dislikes sporting activities, physical education and running
- Ocular motor dysfunction – visual perceptual difficulties and spatial problems
- Poor sequencing skills
- Poor sense of time.

Symptoms of retained TLR – backwards:

- Poor posture – tendency to walk on toes
- Poor balance and coordination
- Hypertonus – stiff, jerky movements cause by the extensor muscles exerting greater influence than the flexor muscles
- Vestibular related problems – poor sense of balance and tendency to motion sickness
- Ocularmotor dysfunction – visual-perceptual difficulties and spatial perception problems
- Poor sequencing skills
- Poor organisation skills.

2.4.2.7 The Symmetrical Tonic Neck Reflex (STNR)

The Symmetrical Tonic Neck Reflex (STNR) is recognised by two aspects. Firstly, the STNR (Flexion) emerges between six to nine months of life and is inhibited between nine to eleven months of life. Flexion of the head causes the arms to bend and the legs to extend. Secondly, the STNR (Extension) which emerges between six to nine months of life is inhibited between nine to eleven months of life. The head extension causes the legs to flex and the arms to straighten (Cheatum & Hammond, 2000: 76-77).

The STNR (also known as the cat reflex) has a very short life-span and helps the baby to defy gravity by rising up onto hands and knees from the prone position. It also helps to facilitate the inhibition of the TLR and forms a bridge to the next stage of locomotion: creeping on hands and knees. The STNR assists with the training of the eyes which is accomplished when the child's focus is adjusted from far to near and back to far (as a result of the head lifted above spine). Goddard (2002:23) points out that the ATNR helps the child to extend the focus from 17cm at birth to arm length; thereafter, with the inhibition of the ATNR at six months, the vision field is extended to distant objects. In the end the STNR brings the vision back to near–distance once more.

Crawling is a very important movement which assists the eyes to cross the midline, as the child focuses from one hand to another. Crossing the midline is important for reading, to be able to read without losing the words at the middle of the line. Crawling also activates the vestibular, proprioceptive and visual systems in working together for the first time. Without their integration there would be no sense of balance, space and depth (Kokot, 2006:18).

According to Goddard (2002:20) even though the STNR enables the baby to get up off the floor, it does not permit mobility in the quadruped position. The STNR is gradually inhibited when the child passes through a stage of “rocking” on hands and knees. If the child does not pass through this stage, they become “bottom hoppers” or even one day they may simply get up and walk.

Researchers Goddard (2002:22), O'Dell and Cook (1997:13), Cheatum and Hammond (2000:44) found that children with retained STNR reflexes showed the following similar responses: when writing the elbow bends and the head goes closer and closer to the paper. Concentration is challenging, reading and writing becomes problematic, added to this is also how it affects copying and spelling. To summarise, amongst the symptoms of a strongly residual STNR, the following is noted:

- The child's posture has the tendency to slump when sitting. This results in the child battling to keep concentration, as he or she has to try to hold the body in an upright position.
- Poor hand eye coordination which results in handwriting problems.
- Difficulties readjustment of binocular vision. The child finds it difficult to change focus easily from black board to desk.
- Slowness at copying tasks, because of the readjustment of binocular vision.
- Clumsiness which will possibly result in a disorganised table and the child will skip words while reading.
- Uncoordinated body movements.
- Difficulties with sense of direction: confuses left and right.

2.4.2.8 Segmental Rolling Reflex (SRR)

Kokot (2006:20) states that the segmental rolling reflex emerges between six to ten months after birth and remains present throughout life. It allows the baby to roll over (supine to prone) and it must be noted that rolling from prone to supine is just as important. The roll starts in the head, then follows the shoulders, thorax and pelvis. This is followed by sitting, four-point kneeling and eventually standing.

Goddard (2002:35) found that children with coordination problems do not have the segmental rolling reflex. They display an inability to use one part of the body without with other parts on the same side locking in. An absence of the SRR includes (Kokot, 2006:20):

- Lack of cross pattern crawling and creeping.
- Hypertonus (high muscle tone) which affects gross motor coordination.
- Inability to cross the midline.
- Difficulty effecting positional changes.
- Lack of fluidity of movements.

2.4.3 Conclusion

Reflexes initiate motor development during the first two years of life, thereafter motor development depends largely on a child progressing through the series of primitive reflexes, postural reflexes and voluntary movements. There are a number of other reflexes which have not been mentioned at all which have an impact on the motor and sensory functioning of the child. The two latter aspects, reflexes and sensory processing, cannot be separated. The reason is that they form part of a main highway of

connections from the motor cortex to the muscles. Ignoring the possible influences of retained reflexes within a movement programme has proven to be problematic to learning readiness. Taking the information discussed into consideration, the following question is posed: Does development take place in a specific order?

2.5 NEURODEVELOPMENT

Recent discoveries in brain research have provided helpful insight into how the brain, the most immature of all the organs at birth, continues to grow and develop after birth. Development depends on the maturation of the nervous system and the neurological connections that proceed all the phases of growth (Walker, 1995:76).

Previously, researchers believed that genetics was the main contributing factor which influenced development. Different experiences, however, are now found to play a major role in helping the brain to develop in different ways. For the purpose of this study, movement has been chosen as one such experience required for optimal development in order to achieve learning readiness. Thus, this section concentrates on the neurodevelopment of human movement.

Neurodevelopment refers to both neuroscience and developmental biology which describes the cellular and molecular mechanisms by which the complex nervous systems emerge during the embryonic development and throughout life. The task of developmental biology is the study of the process by which the organism grows and develops. The processes consist of a variety of aspects:

- Embryonic neural development includes the birth and differentiation of neurons from stem cell precursors.
- Migration of immature neurons from development in the embryo until their final positions.
- Outgrowth of axons from neurons and guidance of the motile growth cone through the embryo towards postsynaptic partners.
- Generation of synapses between these axons and their postsynaptic partners.
- The final stage is the lifelong stages which are thought to underline learning and memory (Van der Westhuizen, 2007:108-109).

2.5.1 Neurological development

In order to understand the neurodevelopment basis of human movement, consideration of the development of the central nervous system and related motor development is required. Karp and DePauw (1989:77) and Seaman et al. (2003:54-57) define neurological development as maturational changes in the structures of the CNS. Neurodevelopment encompasses development in terms of structure (CNS, myelination, brain) function (sensory motor, cognitive development) and the implications for learning (motor and learning).

Rose (2005:65) points out that the brain structure is highly ordered. Neurons have to know their position and with whom to communicate, and ensure that dendrites and the axons make the correct connections. Neurodevelopment entails the developmental sequence which is linked to a timeframe. Within the first month, embryonic development (the formation of brain tissue) starts as early as 19 days after fertilisation (Eliot, 1999:15). The brain structures that control the rudimentary functions, such as breathing and feeding, mature much earlier than those that are more sophisticated (language). Twenty five days after conception, the initial structures of the hind brain, midbrain and the forebrain enlarge and subdivide to make five structures (Figure 2.18).

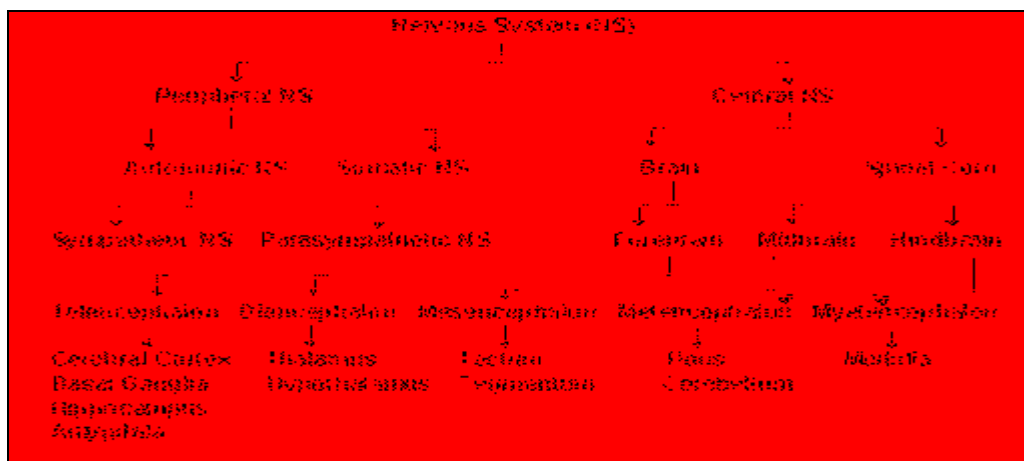


Figure 2.18: Structure of Nervous System

Source: Hager (2006a:4)

Important processes within neurodevelopment are proximodistal (development from the centre outwards) and cephalocaudal (from the head downwards) (Cheatum & Hammond, 2000:205; Seaman et al, 2003:54). Cephalocaudal development starts from the neural tube and progresses upwards and downwards. The brain develops and matures from the spinal cord, which is at brain stem level, and slowly moves towards the frontal regions as in the case of the foetus (Figure 2.19). Van der Westhuisen (2007:115) indicates that the hierarchy includes other systems, one being the sensory system which develops according to a hierarchy. The first to develop is touch, followed by taste, smell and then the vestibular.

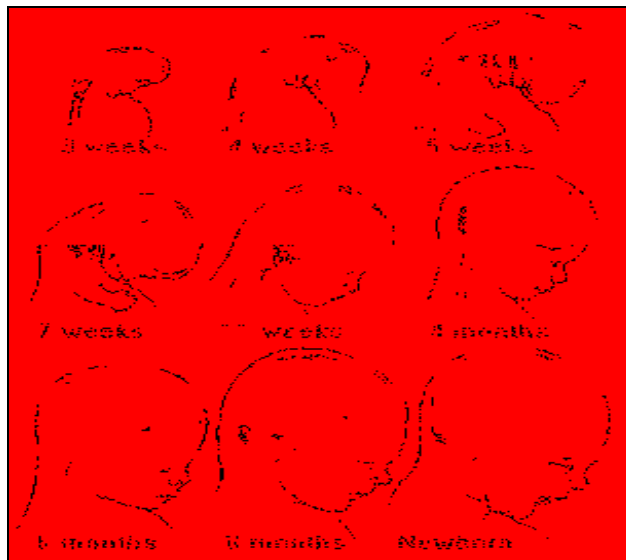


Figure 2.19: Brain development of the foetus

Source: Neuroscience for Kids – Brain development (2009)

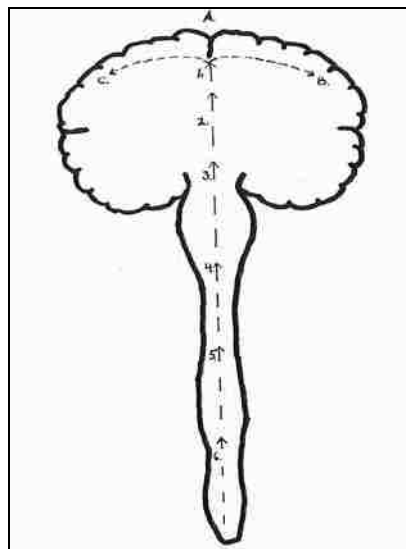


Figure 2.20: Neuro-organisational schema (posterior view)

Source: Delacato (1974:5)

Delacato (1974:47) links neurodevelopment to neurological organisation. Accordingly, Delacato explains that neurological organisation is that:

...physiologically optimum condition which exists uniquely and most completely in man and is the result of a total and uninterrupted ontogenetic neural development. It begins during the first trimester of gestation and ends at about six and one half years of age in normal humans. This orderly development progresses vertically through the spinal cord and all other areas of the central nervous system up to the level of the cortex and it is lateral (from left to right or from right to left). (cf Figure 2.20).

According to Burn (2005), Goddard (2002:115-116) and Kokot (2006:4), the development of the child does not begin at birth but rather at the moment of conception. The systems that are vital to movement

and learning develop very early in utero and play an important role in the execution of movements and the signals that are sent back to the brain. The subsidiary systems (eg visual, auditory, taste and tactile senses) and intrinsic feedback (proprioception) provide information from both inside and outside the body which is relayed to the brain. These senses form the sensory-motor systems that are components that comprise the neurological system. Although the sensory systems were discussed individually in a previous section (cf 2.3) it is important to remember that none of the systems develop and operate in isolation. The optimal functioning of the neurological system requires balance between the different parts. The reflex system is also a system that maps general neurodevelopment.

2.5.2 Growth and development from birth

There are certain stages of growth and development that are common to most children. This results in a child passing through stages in approximately the same order and at the same age as another. Cheatum and Hammond (2000:17) believe that careful examination of the stages of development might reveal that a child at some point experienced certain developmental difficulties that are impacting on or limiting his or her academic or motor abilities. Motor development follows a hierarchical pattern which entails certain qualitative changes in motor behaviour. It also proceeds in an orderly sequential fashion as a result of growth and development of the central nervous system.

Gross motor skills (walking, running) develop before fine motor skills (for example handwriting and bead threading). The order in which the sequence is reached seems to be recognizable. However not all children reach these stages at the same time or the same length of time. Each child is unique and will move through the developmental stages at an age that suits him or her. These stages are milestones which serve as guidelines for progression of development (Cheatum & Hammond, 2000: 19-22).

2.5.3 Development of stages

A closer look at the development during certain ages gives greater insight into the progression of movement, the sensory motor systems, reflexes and structures of the brain which are involved.

2.5.3.1 Stage one: From birth

According to Karp and DePauw (1989:77) sensory input at birth, is characterised by its intrasensory nature. This means the dominance of one sense at a time. Maturity of the somatosensory system is present, and both the tactile kinaesthetic sensory pathways are myelinated to the cortex. Immaturity is found in the visual and auditory sensory systems. The reason for this is because the myelination of the visual and auditory pathways to the cortex only begins at birth. Myelination as described earlier in this chapter is the development of a protein sheath around the pathways of the CNS, which helps to conduct nerve impulses. Structures responsible for the integration of the sensory information are: the spinal cord, brain stem and portions of the cortex. The observable motor outputs are primitive reflexes namely asymmetrical tonic neck reflex (ATNR), righting, stepping, grasping, and sucking reflexes. At this stage a new born responds to touch and loud sounds. Delacato (1974:47) states that the progression of

neurological organisation begins during gestation and by the time of birth the upper reaches are the spinal cord and medulla oblongata. Table 2.1 provides a summary of stage one:

Table 2.1: Neurodevelopment and motor function at birth

SENSORY INPUT	INTEGRATION		MOTOR OUTPUT
	CNS Structures	Myelination	
Intra sensory	Spinal cord Brain stem	Motor pathways to cortex Somatosensory pathways to cortex:	Reflex activity Tonic neck reflexes Righting, Stepping, Grasping, Sucking Responds to loud sounds
Somatosensory mature: Tactile Vestibular	Cortex Parietal lobe Occipital lobe	Somatosensory cortex advanced Motor cortex advanced	Responds to touch on body
Somatosensory immature	Temporal lobe	Visual cortex immature Auditory cortex immature	Visual reflexes, fixation, pursuits
Visual			
Auditory			

Source: Seaman et al. (2003:55)

2.5.3.2 Stage two: one to two years

During stage two as summarised in Table 2.2, the visual system, visual reflexes, fixation and eye pursuits are apparent (Karp & DePauw, 1989:77). The newborn is able to direct the eyes and ears far more effectively to determine the source of visual and auditory stimulation. The child relies primarily on intrasensory information through tactile, vestibular, proprioceptive, visual, and auditory channels.

By three months the child can move his or her head to gaze around and follow movement within the visual field. The eyes are able to converge and follow a suspended object from side to side. The vision and movement in the form of grasping develop separately. The child processes the ability to grasp and release an object and the hands are more sensitive to touch. While the development of the vision continues, voluntary movements begin in the form of neck, trunk and arm movements, and less movements of the leg muscles. These visuo-motor effects will help develop selective attention skills of eye and upper limb reactions which later will help develop visuo-manual grasping (Kokot, 2006: 7-8).

By four months the reflex governed pattern of behaviour changes and visual motor integration becomes progressively more sophisticated. The child is able to purposefully reach for an object within vision. The development of three-dimensional vision starts and the location of objects in space as well as the position of the hand in relation to the objects develops. The child becomes aware of himself or herself and the space occupied and starts to achieve precise directional responses. This is also the start of developing cognitive skills as the child starts to learn about his or her own body and its relationship to and position in the immediate space around him or her (Cheatum & Hammond, 2000:187; Delacato, 1970:77; Kokot, 2006:8).

From six months of age a baby starts to learn to roll from prone (stomach) to supine (back). Babies can lift their heads and chests by using their forearms and palms to support themselves. Head righting reactions are noticeable with the effective head control vertically and horizontal eyes positioning (Kokot, 2006: 8-9). Burn (2005:2) explains that the child at this age has binocular vision. This means if the right arm and leg come up, the right eye looks at the right hand, while the left eye does not. If the left hand and leg come up, the left eye will look at the left hand. Children use one eye at a time (binocular). The same with audition; children learn to turn the head to the side of the sound as sound cannot be placed in space (binaural) at this stage. Mobility is homolateral, leg and arm on the same side move together.

The spinal cord, brain stem and portions of the cortex are primarily responsible for the motor behaviour of the baby during this stage (Karp & DePauw, 1989:78). According to Delacato (1974:48), this is the neurological organisation at lower level which is at the level of the Pons. The motor behaviour is mostly reflexive motor movements. The child also develops voluntary motor control such as head control, voluntary grasping and releasing, rolling, standing and walking. Burn (2005:3) explains that between seven to nine months the child moves to the mid brain level encountering a whole new area of functioning. The child crawls on hand and knees with the stomach no longer in contact with the floor. Movements are not cross pattern in nature, which is distinctly two sided (bilateral). The child uses the eyes in concert and no longer one at a time. The child also learns to use the ears in concert which enables him or her to place sound in space. During this stage the child can pass objects across the midline of the body from one hand to another. The eyes are able to follow this movement which is the start of their training for later reading.

Kokot (2006:9) confirms that the self-mobility increases the child knowledge of the environment. The creeping on all fours also helps to train the head control independently of gravity, and helps to develop skills of stereoscopic vision. The head rotation stimulates the vestibular system and helps to relay impulses regarding the fine tuning to the eye muscles. Crawling is seen as vital developmental experiences which facilitate neural development, perceptual maturation and subsequent neurological integration.

At the age of one year old children start to become cortical creatures and move away from bilateral activity, binocular and binaural to a new level of stereo or depth. They also begin to develop stereopsis in vision. The true cross patterned walking emerges which is superimposed on cross pattern crawling (Burn, 2005:3). The visual system becomes more proficient in its function as motion becomes increasingly complex.

Kokot (2006:10) indicates that from 12 - 18 months onwards motor activity is increasingly visually governed. Body control also increases tremendously leading to automatic motor skills such as walking. This leads to the development precision in visual discrimination and visual-motor coordination.

Table 2.2: Neurodevelopment and motor function from one month to two years

SENSORY INPUT	INTEGRATION		MOTOR OUTPUT
	CNS Structures involved	Myelination	
Intra sensory Tactile Vestibular Kinesthetic Visual Auditory	Spinal cord Brain stem Cortex Occipital lobe Parietal lobe Frontal lobe Temporal lobe	Motor pathways to cortex Somatosensory pathways to cortex: Optic radiation Somatosensory Auditory – incomplete Somatosensory cortex advanced Auditory – incomplete Reticular formation initial Cerebellum commissures initial stage Association areas initial stage	Reflex activity Tonic neck reflexes Voluntary motor control begins Rudimentary movements

Source: Seaman et al. (2003:56)

2.5.3.3 Stage three: two to four years

According to Karp and DePauw (1989:78) the child at this stage (cf. Table 2.3), is able to integrate information from several sensory systems. The spinal cord, the brain stem and the cortex work in collaboration to utilise the sensory motor information which is becoming increasingly more complex at this stage. By the age of four years auditory pathways are myelinated and functionally mature. In general, the child improves with regards to coordination with locomotor, nonlocomotor and manipulative patterns emerging. This is made possible by the functioning of the cerebellum and the basal ganglia. The temporal, parietal and frontal lobes are functional while the maturation of the two hemispheres becomes more apparent.

It is during this period that motor patterns also start emerging as development of the cerebral cortex and the associated areas increases. This development results in an increase in the voluntary motor control which comes from the cortical areas of the brain. Rudimentary movements provide a starting point for the motor patterns which follow. Experiences of visual-tactile, visual-kinaesthetic, and tactile-kinaesthetic are important to develop strong perceptual traces and motor schema (Karp & DePauw, 1989:81; Seaman et al. 2003:56).

According to Kokot (2006:10), the achievement of balance and equilibrium in an upright position becomes more automatic, helping children to advance to more complex movements. The child's ability to control himself or herself is such that the body "divides" itself into two halves so that different motor activities can be carried out and coordinated between each side. By the fourth year smooth coordination of movement should be possible. This is the time that the one side of the body becomes the leading side in motor activities (start of dominance).

Table 2.3: Neurodevelopment and motor function from two to four years

SENSORY INPUT	INTEGRATION		MOTOR OUTPUT
	CNS Structures involved	Myelination	
Intra sensory Tactile Vestibular Kinesthetic Visual Auditory	Spinal cord Brain stem Cerebellum	Increase in reticular formation	Motor patterns emerge Locomotor Nonlocomotor Manipulative Generalise movements coordinated
Intersensory Visual-tactile Visual-kinetic Tactile-kinesthetic	Cortex Parietal lobe Temporal lobe Frontal lobe Occipital lobe Basal ganglia Hemispheres	Increase in association areas Auditory pathways mature Increase in commissures	Responsive to intrasensory and intersensory stimulation

Source: Seaman et al. (2003:57); Karp & DePauw (1989:80)

2.5.3.4 Stage four: Four to seven-plus years

Karp and DePauw (1989:81) and Seaman et al. (2003:56) mention that stage four (cf. Table 2.4) highlights the brain almost reaching the typical size of an adult brain. All the structures of the CNS are functional and all areas are myelinated. The only area not myelinated is the reticular formation which continues until 20 – 30 years of age. The child is able to process information from both inside and outside the body. The motor patterns are more refined with mature motor skills patterns noticeable. The child is able to complete a far more complex motor skill than in the previous stage of development.

The maturation of the visual cerebral cortex is complete and by seven years the child has the ability to accurately fixate on certain points in succession. By eight years of age the child should have decided upon which eye, ear, hand and foot is preferred to conduct activities (Kokot, 2006:10-11).

Table 2.4: Neurodevelopment and motor function from four to seven-plus years

SENSORY INPUT	INTEGRATION		MOTOR OUTPUT
	CNS Structures involved	Myelination	
Intra sensory Tactile Vestibular Kinesthetic Visual Auditory	Spinal cord Brain stem Cerebellum Diencephalon Cortex Hemispheres Lobes	All areas myelinated except association areas and reticular formation, whose myelination continues until 20-30 years of age	Motor patterns refined; mature motor skills develop Complex motor tasks
Intersensory Auditory-visual Auditory-tactile Visual-tactile Visual-kinesthetic			Culturally determined forms of movement

Source: Seaman et al. (2003:57); Karp & DePauw (1989:80)

2.5.4 Conclusion

From birth the child has moved from being one-sided to being two sided and then has to reach the final stage of developmental continuum cortical hemispheric dominance. The child starts making early choices of preferred sidedness which develops to complete unilaterality. The neurological organisation ends at about six years of age which is when formal school begins for some children. According to Burn (2005:3), the whole continuum forms the basis of human perceptual abilities. Perception is a fundamental process:

We learn to see in varying stages and varying ways; we learn to move in varying stages and varying ways; we learn to hear in varying stages and varying ways. No shortcuts can be taken in the developmental processes in any of the sensory modalities, sequentially, logically and according to the development of the human nervous system.

Knowledge regarding the Neurodevelopment basis of human movement serves as the departure point to determining learning readiness. Should it be found that one of the lower level systems are dysfunctional or underdeveloped it could result in a child not being able to learn. One only needs to consider the implications of a child not being able to cross the midline.

Chapter three of this study will take a closer look at the role of movement in preparing the child for learning.

CHAPTER 3

THE LINK BETWEEN MOVEMENT AND LEARNING READINESS

3.1 INTRODUCTION

In the previous chapter, the important role of movement in the neurological development of the child was discussed extensively. Once the child is of school going age, parents and educators are faced with educating the child within the formal school. The question arises as to whether a child is school ready or not. Some children in Grade 1 and 2 may experience barriers to learning and may not be learning ready. The following questions may be posed: Do educators understand the link between movement and learning readiness? What is their understanding of the importance of movement and what is the role of movement in preparing the child for academic learning? In other words, can movement programmes be considered a means to learning readiness?

3.2 THE IMPORTANCE OF MOVEMENT IN EARLY CHILDHOOD DEVELOPMENT AND LEARNING

The quality of the early learning environment and the availability of the appropriate experiences at the right stages are vital in determining the strength or weakness of the brain's architecture to think. An environment deprived of appropriate sensory stimulation results in faulty brain circuitry, which could possibly have effects on further brain development (National Scientific Council on the Developing Child, 2007:1). The sensory system as discussed in chapter 2 (cf 2.3) forms the basis of developing learning readiness and should therefore be considered a priority.

The National Scientific Council on the Developing Child (2007:1-4) points out that mental capacities mature at different stages in a child's development which require cognisance of sensitive periods (Figure 3.1) which occur at different ages for different parts of the brain. Of importance is, lower level circuits which require optimal experiences in order for the higher level neural circuits to carry out sophisticated mental functions. The use of pictures (visual) to stimulate later language and opportunities for stories (auditory) is mentioned as an example of an early learning experience. Linking this to the current study, children require adequate movement experiences to develop the motor abilities considered to be essential for learning readiness.

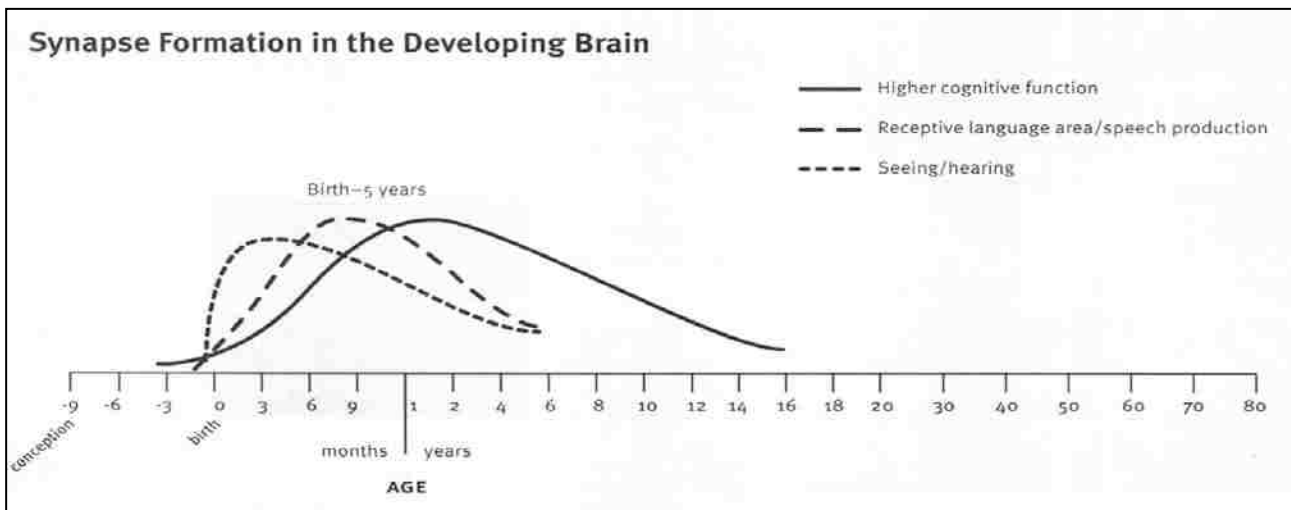


Figure 3.1: Synapse formation in the developing brain during sensitive periods of development

Source: National Scientific Council on the Developing Child (2007:3)

Leppo, Davis and Crim (2000:142) are of opinion that the first two years of life are the start of an individual's recognition, understanding and thinking; all these are a result of movement experiences and their consequences. They see the early years of life as presenting ideal opportunities for children to learn to develop control of their muscles and movement. These are critical years during which neural pathways develop through the process of myelination (cf. 2.3.1.). Educators and caregivers influence the child's ability to learn by providing enriched sensorimotor environments that contribute to the growth of dendrites and synapses. Sorgen (in Leppo et al, 2000:142) argues that without proper environmental stimuli during infancy, the sensory pathways of the brain may not develop properly and motor skills may remain underdeveloped.

Ratey and Hagerman (2009:5) state that moving our muscles produces proteins that travel through the bloodstream and into the brain, where it plays a pivotal role in the mechanisms of our highest thought processes. They further mention that the neurons in the brain connect to one another through "leaves" on treelike branches, and that physical activity causes the branches to grow and bloom with new buds, thus enhancing brain function at a fundamental level. They are also of the opinion that to keep the brain at peak performance, the body needs to work hard.

Cheatum and Hammond (2000:17-19) also argue that early childhood experiences, namely neurological growth and development, skill development, the primitive reflex system (cf. 2.4.1), as well as various motor and perceptual concepts, have a profound influence on children in their motor development and academic learning. Physical activity promotes neural growth which in turn enhances motor development. Hannaford (2005:15) is of the opinion that we have all missed a most fundamental and mysterious aspect of the mind: learning, thought, creativity and intelligence are not processes of the brain alone, but of the whole body. It is emphasised that the body plays an integral part in all our intellectual processes from our earliest moments in utero right to old age.

As seen in chapter two of this study, the very first sense of movement of the child is in utero (cf. 2.4.1). Goddard (2002:55) recognises that it is through sensory motor functioning that children experience their world. The basic motor activities help children build a repertoire of motor information about their own body, its movement potential, and its relationship to other objects in the environment. Many parents are too protective over their children not allowing them to develop the necessary skills required to develop. Climbing trees, running around and playing allows children to become proficient in overcoming problems. Learning by movement and experience is considered vital to the child's total development.

Hannaford (2005:111) and Leppo et al. (2000:142-143) also all emphasise the link between movement and learning. They indicate that with the execution of movement by the child, various connections are created between the dendrites and axons of various neurons in the brain. Repetition creates additional connections between the neurons and a more secure pathway is established. Movements become more established as the neurological pathways are established. All learning takes place in the brain, yet it is the body which acts as the vehicle by which knowledge is acquired. The brain and the body work together with the CNS which is situated in the spinal cord. Movement is seen as contributing to the growth and development of the brain as it forms the building blocks on which later learning is based. Movement plays a vital role in activating the neural wiring in the brain and it reflects neural organization and provides the stimulation to neurological systems which are necessary for the child's development and optimal functioning.

Movement thus forms an integral part of all mental processing. The body can be seen as a sensory-motor response system as it causes the brain to learn and thus to organise itself. Movement plays a vital role in the creation of nerve-cell networks essential to learning. Learning takes place through various senses, namely, through the body (kinesthetic), sight (visual), hearing (auditory), touch (tactility) and taste (gustation). The more the senses are involved, the better the degree of learning. Children need to learn how their bodies function in space (spatial awareness), what their bodies can do (up, down, in, out, around – directionality), that they have a left and right side, a top and bottom (laterality) which also function separately from each other (Fredericks, Kokot & Krog, 2006; Goddard, 1995; Pheloung, 1997; Cheatum and Hammond, 2000; Hynes-Dusel, 2002:18).

Children need to have opportunities which involve coordinated movements of both eyes, both ears, both hands, both feet as well as the core muscles. Their movements involve the incorporation of both sides of the brain thereby increasing cognitive functioning. Two areas of the brain that are associated solely with control of muscle movement, the basal ganglia and the cerebellum, are also important in coordinating thought. These areas are connected to the frontal lobe area where planning the order and timing of future behaviours occurs (Hannaford, 2005:37).

According to Summerford (2001:7), movement is known to be centrally important in learning and memory, and an exercise stimulated environment is more conducive for learning. The study conducted by Summerford (2001) on exertion in elementary schools indicates the subjects performed significantly better on maths problems after 50 minutes of physical exertion than after no exertion. The cerebellum is

connected to the regions of the brain that perform not only motor movements but also mental and sensory skills in the human brain. As with motor skills, several advantages occur from learning to perform the other skills automatically, without conscious attention to detail.

Hannaford (2005:192-194) states that the body is closely linked to the brain through all the various nerve synapses. Physical exertions also release endorphins into the blood stream - thus movement triggers the brain to create chemical changes in the body. Each movement a child makes is thus a thought out and planned action (even reflexes are movement lessons that the body has learnt, stored and calls upon). Another recent study conducted by Ratey and Hagerman (2009:5) has also proven that when a person is involved in physical activities, chemical changes take place in the brain which enhances the learning capabilities of the person. Exercise is seen to boost a number of brain cells in the hippocampus which plays an important part in long-term memory and spatial navigation.

Jensen (2000b:34-35) points out a number of other important physiological reasons for the inclusion of movement in the curriculum. Reasons include the increase of the heart rate and circulation. Oxygen is sent to key brain areas, which helps the eyes to relax, the body is able to get rid of musculoskeletal tensions, increased physical arousal is achieved and the child's attention is narrowed to a target. Certain movements can stimulate the release of the body's natural motivators: noradrenaline (the hormone of risk) and dopamine (the neurotransmitter producing good feelings). Movement also provides the child with a much needed break from learning. The brain needs a break from unlimited amounts of explicit content. It is especially the hippocampus that organises, sorts and processes the incoming information before routing it to other areas of the cortex to be stored for long term. This structure can become overloaded which results in no new learning.

3.3 PHYSICAL AND MOTOR DEVELOPMENT

The growth of a young child's physical abilities is truly amazing. One only needs to think of all the physical abilities a child must develop to adjust to the world: learning to see and recognize others, rolling over, holding a bottle or cup, crawling around objects and many more. These are all considered complex physical tasks that require strength, coordination and perception. They are also developmental moments, a time when parents or caregivers can see the ways in which a young child is growing and developing new skills and abilities. Parents are in a unique position to support and encourage an active lifestyle among very young children (Eastman, 1997:161; Pica, 2004:3-5).

Brotherson (2006:1-3) defines the *motor development* as physical growth, or growth in the ability of children to use their bodies and physical skills. Motor development has often been defined as the process by which a child acquires movement patterns and skills. Genetics, size at birth, body build and composition, nutrition, rearing and birth order, social class, temperament, ethnicity and culture influence motor development. Many times in thinking about physical development, one thinks most about *gross-motor development*. This refers to the use of large-muscle groups in the legs or arms. However, *fine-motor development* is also included in the physical development of a child and deals with such areas

as smiling, picking up a spoon or tying a shoe. Fine motor development is evident to parents and educators as infants grasp food to put in their mouths and it is enhanced by activities such as picking up blocks, drawing with crayons or trying to pick up balls. According to Hansford (1992:28), the basic process of normal motor development plays an essential part in the acquisition of all skills. All these skills have a major role to play in effective classroom functioning.

Physical development provides children with the abilities they need to explore and interact with the world around them. A young child's physical growth first begins as muscles gain strength with use and he or she gradually develops coordination. The development of muscular control is the first step in this process. Physical development encompasses so many different tasks and abilities, for example, crawling across the floor is a task young children engage in that involves physical development. It also involves activities such as running around outside, jumping on the bed, grasping a parent's finger or using a pencil to draw in a colouring book. It is important to know where these tasks all fit in the world of physical growth and development. According to Pica (2004:4-5), the simplest reason why children should be allowed to move is in order to develop and improve movement skills necessary for learning.

3.3.1 Phases of motor development

Gallahue, Werner and Luedke (1975:6), well-known researchers in the field of physical education, refer to six phases of motor development (Figure 3.2) which are of importance in the curriculum. They acknowledge that the child's motor development (i.e., the development of movement) follows a sequential pattern, moving from very simple to highly complex movement in a hierarchical way. These phases were designed in order to indicate where most children are in the development of their movement skills. Not all children pass through the phases at the same time, but these phases serve as an indicator for parents and educators as to when emphasis needs to be placed on the development of the varied degrees of skill.

The importance of knowledge regarding the child's motor development is that it gives educators and parents clues as to how to teach children best. Each phase is briefly discussed in the section to follow. For the purpose of this study it must be noted that the emphasis is placed on reflexive behaviour, rudimentary movement abilities and fundamental movement patterns. The researcher considers the mentioned three phases as prerequisites for learning readiness. Each phase builds upon the previous phase as it is vital for progression to the next phase.

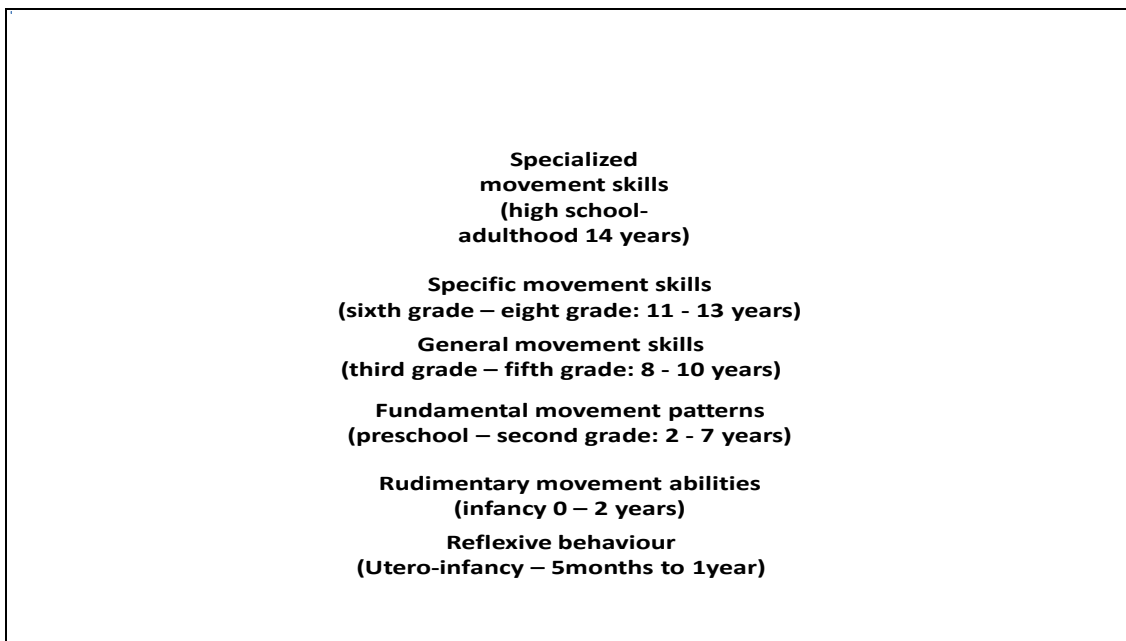


Figure 3.2: Phases of motor development

Source: Adapted from Gallahue et al. (1975:5)

3.3.1.1 Reflexive behavior

The reflex system has been discussed in detail in section 2.4 of this study, therefore limited detail is provided here. This phase stretches from in utero to between five months and one year. During this stage involuntary movements of the body are noticeable. The involuntary movements are subcortically controlled and consist of primitive and postural reflexes. Primitive reflexes, such as rooting and sucking reflexes, are considered the survival mechanisms for the newborn. The primitive reflexes are transformed in order for the postural reflexes to take over in order to help control body movements. Many of these postural reflexes resemble later voluntary movements. Knowledge regarding the reflex behavior is vital as together with the normal development of the child, insight is gained into the motor abilities of the child which could have an impact on learning (Gallahue et al., 1975:6; Goddard, 2002:1).

3.3.1.2 Rudimentary movement abilities

Rudimentary movements are the first voluntary movements of an infant between birth and about two years old. The development of efficient and effective forms of these rudimentary movements during infancy helps to form the basic building blocks for the development of more difficult movement tasks (Gallahue et al., 1975:6). The rudimentary movement abilities are influenced by maturation and development. They follow a sequential pattern which enables neurological development. Each movement builds on the one just gained to form a sound foundation, which is important for learning to take place. These movements have been included in a movement programme: “Move to Learn” designed by the Australian, Pheloung. Due to the plasticity (the ability of the brain to adapt or change in response to demands of the environment) of the brain, this programme has been proven an effective means of increasing neurological maturity and integration (Pheloung, 2006,17). The visual presentation of the most important rudimentary movements is included in Figure 3.3.

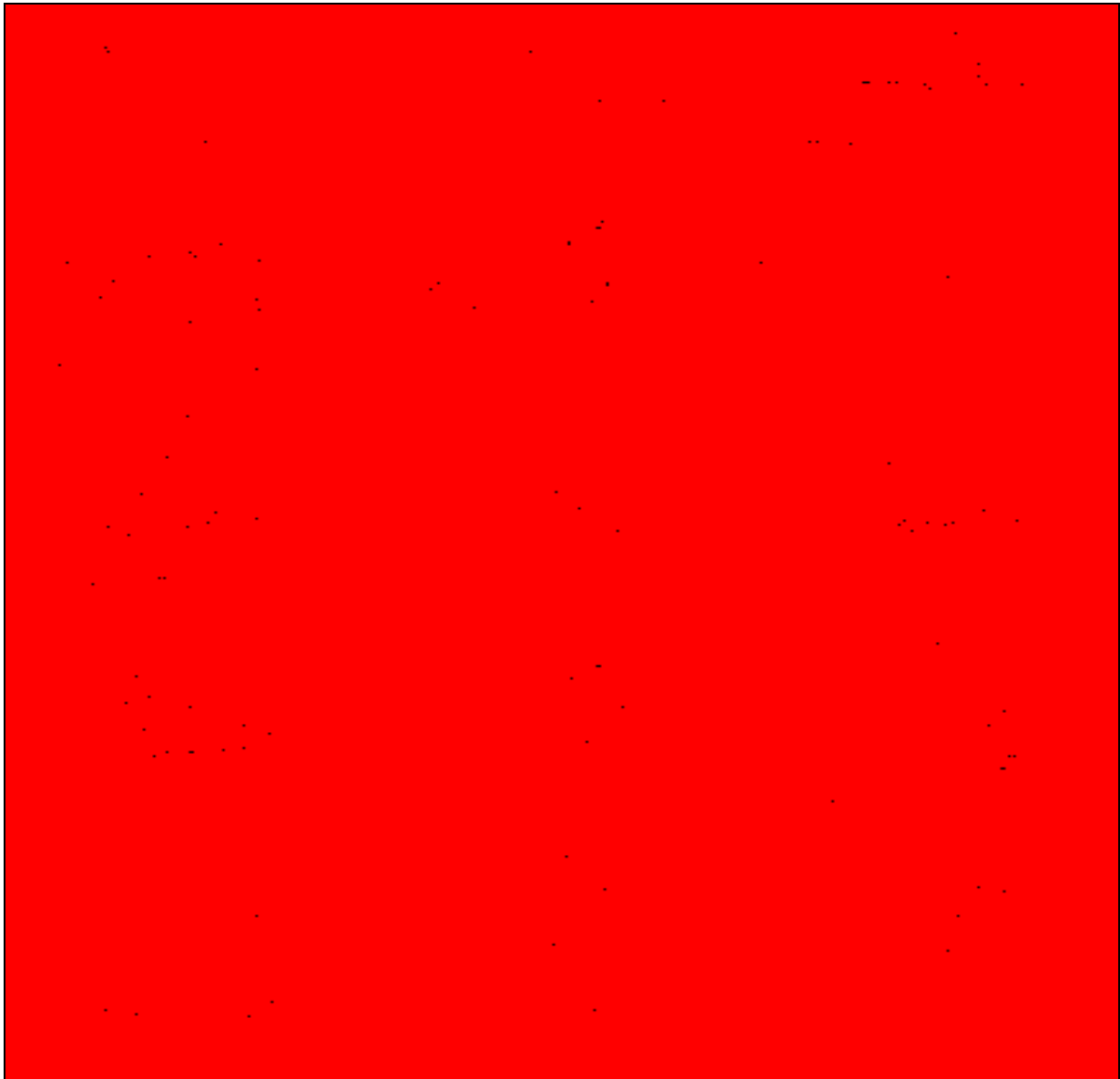


Figure 3.3: Rudimentary movement phases

Source: McCall & Craft (2000:154)

The importance of the rudimentary movement phase and its effect on learning is vital. Goddard Blythe (2006a:2) points out the important link stating that a child first has to gain control over movement and the ability to sit or stand still, before he or she has the fundamental equipment necessary for learning in the classroom. I would also like to highlight certain milestones in the child's development and the relevance thereof to learning.

a) Prone with head extension

The *lifting of the head* when lying in prone (on stomach) is the start of motor development as the child attempts to move against the forces of gravity. This continuous lifting of the head enables the baby to develop muscle tone which is required when sitting at the desk in the classroom. Goddard Blythe (2006a:2) states that infants first need to gain control of the head before they can gain complete control

of the rest of the body. This development on the tummy is seen as far more important than the development when lying supine (on back) (Liddle & Yorke, 2004:43-47).

The child develops from total body movement, with any movement of the head causing a reflexive movement of the limbs on one side, to independent head and limb movement. The child then progresses to bringing one side of the body to the midline and eventually is able to cross the midline from one side of the body to the other (Goddard Blythe, 2006a:2).

b) Rolling

Rolling is important in the sense that the child learns to defy gravity and cross the midline. This skill is required later on when the child needs to cross the midline when reading from left to right, performing writing activities (the figure 8), passing objects across the body and tying shoe laces (Pheloung, 1997:36 & 53). According to Pheloung, (1997:35), the benefits of rolling include creating optimal brain connections between the eyes, the hand and other parts of the body. The child needs to be able to control the body which requires a certain degree of muscle tone.

c) Sitting

Sitting and hand movements develop simultaneously. Hand movements are those required for eating, playing and coordination. When sitting the hips and shoulders need to work separately in order for the child to rotate. The child also needs to be able to keep the head up and turn it in various directions. Sitting helps to develop muscle tone and balance which is necessary for aiding the child in the classroom (Goddard Blythe, 2006a:2). Hansford (1992:28) emphasises the ability of the child to maintain balance in order to provide a stable base for the effective performance of eye-hand and fine motor function. Good stability frees the child to direct his or her attention to a wide variety of tasks required in the classroom.

d) Crawling

Crawling is a very important milestone in motor development. It helps with the child's visual development especially the near point vision (Goddard, 1995:35). The baby starts out by following the movements of the hand, which in time together with elaborate nerve networks lead to the development of hand-eye coordination (Hannaford, 2005:116). Crawling is also the start of integrating the left and the right side of the body. De Jager (2009:102-103) maintains this integration is necessary for walking and to stabilise the shoulder girdle as it forms the basis of later fine-motor control, necessary for stacking blocks, holding crayons and cutting with a scissors. It is also essential to help with goal setting and planning towards achieving goals. Crawling is a major milestone for the development of spatial awareness (proprioception) as it enables the child to distinguish left from right, as well as to avoid the reversal of letters like b, d and p.

Both Liddle and Yorke (2004:71) and Pheloung (1997:35 & 53) agree with the importance of crawling stating that it forms the basis for good vision, handwriting, balance and integration of the two sides of the

brain. It increases strength and coordination, especially in the shoulders, wrists, hands and fingers, which are required for later manipulation skills. The creeping action helps put pressure on the pinky side of the hand which helps with the development of later fine motor skills required in writing.

The time the child spends on the floor is extremely necessary to build proximal (shoulder, trunk and hip) strength and distal (limb, and hand) strength. These strengths are, according to Liddle and Yorke (2004:72), critical to the child's development. Crawling helps with the development of the vestibular, proprioceptive and visual systems which can connect to operate together for the first time once this movement starts (Goddard, 2002:23).

3.3.1.3 Fundamental movement patterns

Fundamental movement patterns are established between the ages of two to seven years. These patterns develop from the rudimentary movement abilities during the early years in which young children explore and experiment with the movement potential of their body as they run, jump, throw, catch and balance their bodies. Movement is general rather than specific with movement patterns that are characterised by the ability to move in various ways to a given stimulus. The environment needs to be structured so that the young child is able to be successful and able to achieve the maximum.

3.3.1.4 General movement skills

Gallahue et al. (1975:6) state that the general movement skills are developed between the ages of eight to ten years. They consist of much the same elements as seen in the fundamental movement patterns. However, more emphasis is placed on accuracy, form and skilled performance. At this age children become more involved in a wide variety of sport skills that are important for individual and team participation. Even though the sport skills are aimed at more complex and specific forms of fundamental movements, they are aimed at exposing the child to, and the development of a reasonable degree of competence.

In my view, this phase of development is essential for it includes children who could be experiencing barriers to learning. The implication is that it would be beneficial for these children to revert to the previous phases as they might have problems with the execution of rudimentary and fundamental movement patterns.

3.3.1.5 Specific movement skills

Specific movement skills are developed from eleven to thirteen years and consist of a further extension of general movement skills. The emphasis is, however, on form, skill and accuracy. The complex sport skills are refined and utilised in performing advanced lead-up activities and require a more acute refinement of a variety of sport skills. Specific skill development is an important stage in this particular phase of development. The aim should also be to develop and refine fundamental and general movement abilities (Gallahue et al., 1975:6). As this phase occurs after the age of school entrance no further attention is given to it here.

3.3.1.6 Specialised skill development

Specialised skill development starts in the 14th year and continues into adulthood. The number of specific skills which need to be developed are isolated and developed at a higher level to enable performances which range from recreation activities to Olympic standard achievements. It is suggested that this specialisation process should not begin too early as it may be at the expense of developing general and specific movement skills. According to Gallahue, et al. (1975:6), the emphasis should be on learning to move more effectively and efficiently through the environment in a variety of ways.

3.3.2 Developmental milestones

It is important to understand the phases of motor development as it allows parents and other adults to be aware of what to expect of a child physically at different ages. For example, expecting a 3-year-old child to zip his or her own jacket would be unrealistic because he or she is still developing the physical ability to use fingers in that way. To be more specific, I would like to pose a further question: How do you know what a child should be able to do physically? Typically, educators can refer to *developmental milestones* to indicate steps in physical ability for a child that should be reflected at different ages, such as during the 4- to 6-month period or between 2 and 6 years (cf Addendum A-E).

When considering the various developmental milestones, a child's parents and educators will become aware of the child's motor abilities. It must be noted that progression through the stages occurs in an orderly, predictable sequence of development. Gross motor skills (e.g., walking) develop before fine motor skills (writing), and babble precedes any talking. All too frequently one finds that developmental difficulties are due to problems experienced during the stages which could limit a child's academic, behavioural or motor abilities (Cheatum & Hammond, 2000:17-19).

Looking at the research findings in the literature discussed (cf 3.2), the link between movement and learning cannot be ignored and therefore this study attempts to emphasise the importance of movement within the curriculum of the Early Childhood Development and Foundation Phase. The Revised National Curriculum Statement Grades R-9 (RNCS-schools) gives an outline of the Learning programme for the Early Childhood Development and Foundation phase. It consists of literacy (40%), numeracy (35%) and life skills (15%) which are each allocated a certain percentage of teaching time respectively (Department of Education, 2002b:17). Further, Life Skills consist of various learning outcomes: Health promotion, Social development, Personal development, Physical development and movement as well as Orientation to the world of work. The outline policy indicates that physical and motor development is integral to the holistic development of learners. It makes a significant contribution to learners' social, personal and emotional development. Play, movement, games and sport contribute to developing positive attitudes and values. This area focuses on perceptual motor development, games and sport, physical growth and development, and recreation and play (Department of Education, 2002a:6).

Due to the importance of movement which has been pointed out so far, a brief overview of what the literature reveals about the modern child will be discussed in the next section.

3.4 THE MODERN LIFESTYLE OF TODAY'S CHILD

Modern society places a tremendous strain on the development of children's movement. The housing conditions, influx of people to urban areas, too few public playgrounds and the long hours spent indoors are impeding the child's experiences in motor development. Children spend hours watching television, playing play station and computer games which encourages a sedentary lifestyle. This leads to a number of academic related issues such as inability to read, visual problems, motor problems, complications in written work as well as general lack of muscle tone. Children are transported to school and no longer walk or ride bicycles (Nel, 2002:3; Werner, Timms & Almond, 1996:48).

Hannaford (2005:74-76) confirms that spending hours in front of the television leads to a developmental lack of imagination that reduces full sensory, motor, emotional and human interaction. Children's ability to process is exhausted by an over stimulation in their attempts to follow what is happening on the screen. The effect is that the eyes go into ocular lock (staring) and disassociative hearing (no connections between word and pictures). Further, the body goes into a stress mode that inhibits all learning and memory. It also leaves the child irritable and fearful. Another impact is that children exposed to a learning scenario that lacks physical, emotional and sensory learning, which will accordingly affect lifelong learning.

Parents also place restrictions on their child's movements: "Be careful not to bump this"; "Lift your hands like this...."; "Watch out for". This puts further restraints on their activities. Olds (1994:33) comments that in childcare settings children are relegated to a playground or a single climbing structure. This is a sure way of halting the development of motor abilities. Children must be allowed to move and express themselves in a variety of ways. Failure to meet the varied needs for movement prevents children from having experiences which are fundamental to their intellectual, social and physical development. Gagen and Getchell (2006:227) echo this by stating that teachers need to concentrate on designing developmentally appropriate activities which encourage motor development.

With the above in mind, the current Revised National Curriculum Statement for South African public schools gives guidelines to educators. Included in the RNCS is Learning Outcome 4 which deals with physical development and movement (cf Addendum F). The essentials for learning readiness which I consider to be important (cf 3.3 & 3.6) are not always followed by educators. Educators often resort to free play which results in children being allowed to be inactive. The need for structured motor development and intentional learning should be emphasised.

The modern child is almost resigned to biological deterioration and physical decadence due to their inactivity and idleness (Nel in Kokot, 2006:3). Research conducted by Nel showed that ninety eight percent (98%) of all students choose a passive above an active lifestyle; the average child spent 23 hours per week in front of a television set, and only ten percent (10%) of students took part in

competitive sport. Today, children are further seen as a product of a television generation that has forgotten how to play, climb trees or perform manual task around the house. The security factors in South Africa have further restricted the child's desire to play in parks and ride bicycles. Homes are tiny compartments, gardens are far too small and both parents are required to work longer hours which prohibits them from spending time with their children; children are left in day care centres for virtually the entire day. Probably the biggest constraint worldwide is untrained staff who are not qualified to run movement programmes (Kokot, 2006:3; Gagen & Getchell, 2006:228). In workshops that I conducted between 2003 and 2009, I found that many educators are also unaware of the impact of poor motor development on the child as well as on their development at school.

According to Kokot (2006:1-3), many six-year olds are not ready to learn on entering Grade 1. Many preschool teachers recognise that too many children have not acquired school readiness skills as they should have. It is assumed that the daily school programme includes activities which keep up with the child's development, but it is not the case. Kokot (2006:1-3) is of the opinion that the activities required for readiness need to be taught and practised in order for the child to learn the skills needed for school success. Readiness skills are considered to be a complex cluster of more basic abilities. This includes the child's ability to locate objects in space, have knowledge of body parts, midline crossing, laterality and directionality.

From the previous discussions, it is clear that the child has an insatiable desire for movement. Most have observed the desperate striving of a toddler to take the first step, breathless active young children running on the playground and the constant squirming of learners confined to their desks. Yet it is the educator and parent who suppress the urge to move. Parents continuously ask their children to sit still, stop fidgeting, and to pay attention. According to Hynes-Dusel (2002:18), it is the education system itself that considers learning to take place only when learners are sitting still and facing the teacher. I want to point out that many children find it virtually impossible to sit still and are very soon labelled as being "hyperactive" when in fact they are in need of movement to keep their systems functioning.

In discussions with primary school teachers during numerous workshops which I have conducted across the country, educators expressed their similar concerns about the gross motor and fine motor abilities of children, the ability to concentrate and sit still, crossing the midline, their knowledge of directionality, laterality, visual tracking abilities, auditory sequencing problems were only a few of the issues mentioned. They questioned the emphasis placed on movement in the curriculum in early childhood development, as far too many schools focus only on drawing, colouring in and writing. They commented that some educators spend far little time on movement and do not really know to implement it in the curriculum. A large percentage of the Grade one learners lack the most basic gross motor skills required to cope in school and to be considered learning ready. I agree with De Jager (2009:29) who states that the body remains the fixed point of reference despite the constant changes and movement around the body. One can also agree with Hannaford (2005:15) who states that, "Learning is not all in the head!"

Therefore, attention needs to be placed on the requirements for learning readiness and the essential learning which takes place through movement.

3.5 ESSENTIAL LEARNING WHICH TAKES PLACE THROUGH MOVEMENT

3.5.1 Spatial knowledge (awareness)

Children need to experience orienting their bodies in space by going up, on, under beside, inside, and in front of things. Should they not be subjected to spatial orientation, it is possible they will have difficulty dealing with the letter identification and orientation of symbols on a page. The difference between p, b and d depends on orientation in space. All are composed of a line and a circle. It depends on which side of the circle the line is. Motor movements serve to promote sensory integration. Movement also provides the opportunity to learn left and right which is crucial to reading. A child who does not know left from right will not know where to start reading, could skip lines and stop in the middle of the sentence (Burn, 2007:1; Corso,1993:6-7).

Movement in space using the whole body forms the foundation for school readiness tasks like reading, writing and maths. The concept of space and the position in space is not something that can be taught to a child. A child has to experience position in space through movement. As in the example already given, p, b and d are all the same shape, only their positions differ. The teacher is the mediator in providing the child with spatial experiences (Corso, 1993:6-7).

3.5.2 Knowledge about the topology

According to Calitz (1997:34), topology refers to the internal map of each child's surroundings. In the beginning it is constructed by the young child's knowledge of the concrete surroundings. Jensen (2000b:34) states that movement gives a child a new spatial reference and thus enhances spatial learning. The brain forms maps of the body's relationship to the scenery. The function of this concept is to help children with knowledge of direction and knowledge of position in space as well as forming an important ingredient of problem-solving. Knowledge of direction includes, up, down, around, under (Calitz, 1997:34). This knowledge is essential within the classroom setup, especially when calculation, writing and reading takes place.

3.5.3 Foreground/background concepts

It is very important for children to be able to distinguish between objects that are near, far, in the foreground and in the background. These concepts are closely related to the spatial concepts and topology. Example: when a child needs to throw a beanbag into a box, he or she needs to know how far and in which direction to throw (Calitz, 1997:34). In the classroom the child must be able to distinguish what is in front of him or her and what is on the board. An infant that does not experience the body in space (tummy time and crawling) will find this concept rather difficult later in life.

3.5.4 The ability to focus on a specific point

According to Hannaford (2005:116), on entering school, children are often expected to develop their focus quickly in order to see small, static, two dimensional letters on paper. The transition from three dimensional (working with shapes in preschool) and peripheral focus is very abrupt and in many cases unnatural.

In order to catch a beanbag, write in a specific place or read a word, a child needs to focus on a specific point and keep his or her focus until the task is completed. Experiences in movement help with the development of focussing, that is, keeping an eye on the ball until it is caught. Ocular motility is therefore required. This motor skill is also required in drawing, reading and writing exercises (Kokot, 2006:71-72).

3.5.5 The ability to follow an object through space

There is no possibility of teaching children the ability to follow an object through space other than through practical experience. Examples are, for instance, to follow the beanbag with the eyes only, anticipation where the beanbag is going, positioning to catch and anticipating the force and direction the beanbag needs to reach the target. Experiences over long periods are required to develop the perceptual-motor abilities necessary for the tasks. The ability to follow an object in space is important when it comes to following a written line from left to right and back to left, as well as to continue with the following line. This action is required for reading and written work. Numerous experiences in moving, kicking and throwing will help with acquiring speed to read (Calitz, 1997:34). The more the eyes move, the more the muscles of both eyes need to work together. Visual stress occurs when eyes cannot focus effectively or track together. According to Hannaford (2005:116), this is due to a lack of integrated whole body movement and vestibular system development.

3.5.6 Body awareness

There are numerous perceptions as to what body awareness is. Terms include *body image*, *body concept* and *body schema*. According to Cheatum and Hammond (2000:85), *body image* is seen as self-concept. A positive body image will enable a child to experience movement as successful. Problems with body image are seen in drawings of children who do not draw the various body parts as they lack the necessary skills to do so. Movement promotes a sense of self (who I am and what can I do). Hannaford (2005:44) states that proprioception contributes to the development of a physical sense of self or body image – the internal awareness of the body parts.

Body concept is seen as the child's knowledge of his or her own body parts. By seven years of age, children should be able to name the minor body parts such as wrist, ankle and shins. (Cheatum & Hammond, 2000:92). Cheatum and Hammond (2000:98-99) point out that *body schema* is an internal awareness of where the body parts are in relation to each other. Muscles, joints, skin and soft tissue feed the messages to the brain. A lack of body schema is seen when children are unable to coordinate their movements. Positive movement experiences where a goal is reached or emotionally important

adults are pleased, forms a positive self-concept in the child. Hand dominance as well as reading is based on a sound body image.

3.5.7 Problem solving

Movement assists with the skills of problem solving that are acquired on the basic concrete level in the early years. Exploration of the environment and creative problem solving forms an important part of the cognitive thinking process. Young children solve problems by trial and error (Calitz, 1997:35). Climbing trees, building puzzles and packing blocks, are some of the activities which help develop and acquire the necessary problem solving skills required for learning.

3.6 THE REQUIREMENTS FOR LEARNING READINESS

When children communicate they require skills related to both motor and mental activity, the motor activity of speech or gesture, and the mental activity that formulates what is to be said. In the course of learning these skills, individuals' performance can be improved considerably through practice so that the skills eventually can be performed without conscious attention to detail. Sitting at a desk requires a well developed balance system (vestibular). This system starts developing in utero and requires movement to enhance its functioning. Speech is dependent on the motor system for the control of the lips and tongue. Writing is a motor task which relies on the coordination of the eyes and the hand with the support of the postural system. Reading is an ocular motor skill which is dependent on the proper functioning of the vestibular system, proprioceptive system and the visual system (Cheatum & Hammond, 2000:125-127). Therefore the sensory systems have to be in sync to enhance quality learning. Goddard Blythe (2000:154) is of the opinion that one has to consider the "ABC" of learning in order to gain optimal learning readiness. The 'ABC' stands for Attention, Balance and Coordination which are discussed below apart from other aspects also discussed thereafter.

3.6.1 Attention

When children have to pay attention, they require the ability of focussing of conscious awareness upon a specific task, particularly when that task is being learned, and they require a high level of arousal. Attention depends on the ability to reject irrelevant sensory stimuli such as: background noise, movement within the visual field (someone walking past the open door) and sensations from the muscles and skin (the irritation of the chair or someone standing close to them).

According to Goddard Blythe (2000:154), in the early stages of development it is normal to be stimulus-bound. A child's capacity for sustained self-directed attention starts to increase at the same time as basic perceptual-motor functions mature. When given any task a balance must be struck between sensory-motor and cognitive processing. If the demands of body management are great, then less information processing can take place at a cognitive level. Motor skills are expressed through

movement, balance and posture. The child's motor abilities at key stages in development can provide insight into his/her development level of operation.

3.6.2 Balance

This refers to the control of the body. It is the most advanced level of movement in order to stay totally still. A larger support surface is required by the baby to support the whole body (think of a small baby lying on the stomach and eventually having to stand on only two small feet and still stay balanced). As balance improves, less movement and support from other body parts is required. It is necessary that the child gains mastery over the most basic developmental skills in order to move to the next level (Goddard Blythe, 2000:155; Leppo et al., 2000:145).

3.6.3 Coordination

Coordination is as a result of all the body parts working together in an efficient organised way. This is an essential functional link between learning and movement. Children (aged 5 - 6) who find it easy to control their body's movement, to sit still and focus their attention on a specific task, are showing that they are neurologically ready to begin learning. Research has shown that the body acts as a "receptor" for information and the medium through which knowledge is expressed. By using specific movement exercises, for reflex stimulus, various reflex abnormalities have been corrected and this has resulted in improved reading and writing activities. In order for a child to sit or stand still and pay attention, entire muscle groups must work together in co-operation with balance and postural systems (coordination). Coordination requires the brain to gain control over balance, posture and involuntary movement (Goddard Blythe, 2000: 155; Leppo et al., 2000:145).

Goddard Blythe (2000:155) states that between the ages of six and a half and eight years old the myelination is completed which strengthens neurological connections between the vestibular system, the cerebellum (coordinator of fine motor movements) and the corpus callosum (connection between the two cerebral hemispheres). It is only once these systems are operating in sync that the child's sense of direction becomes stable. Movement can be effectively used as a tool in order to help the child develop emotionally, intellectually and physically. Incorporating movement has various benefits with regards to learning. These will be discussed in the next section.

3.6.4 Laterality

This refers to the internal awareness of the two sides of the body namely left and right and that the two sides are different. Children start to develop this sense at the age of 4 years. By the age of 7, 70 % of children should be able to identify the two sides of the body. Should children at the age of 10 not be able to identify left from right they could be at a learning disadvantage. Lateral preference refers to the use of the eyes, hands and feet on the same side of the body. Laterality serves as the foundation for directionality (Cheatum & Hammond, 2000:101-103; Kokot, 2006:39). Deficits in this area show up in

reading when the child is unable to see words consist of letter combination, reading is from left to right, and one is required to hold a book right side up to read.

3.6.5 Midline

The midline is an imaginary line dividing the body into equal parts, two sides, top and bottom, front and back. The midline is like a wall that keeps a child from crossing one arm or leg across the centre of this body into the other half (Pheloung, 2006:261). Midline crossing develops automatically after a child has developed lateral preference. It could sometimes only develop at about seven years of age (Cheatum & Hammond, 2000:110-111). If this persists, it slows down academic work when both sides of the brain should be working easily together (Pheloung, 1997:113).

Certain movement activities provide the opportunity for children to enhance crossing the midline. If the child has not acquired the skill, it will have a devastating effect on school performance. Children who cannot cross midline tend to focus on the paper with a vertical orientation, sometimes writing or drawing down the longitudinal centre of the page and sometimes changing the pencil to the other hand at the midpoint of the paper. Children who cannot cross midline tend to stop reading in the middle of the line (Corso, 1993:6).

3.6.6 Directionality

Only once a child has developed a well-defined sense of laterality and knowledge of the body can directionality be built. The child transfers knowledge of the right and left sides of the body into space. Only once the child has learnt laterality can the three references of directionality be learnt, namely, left and right, up and down, and in front and behind (Pheloung, 1997:110; Pheloung, 2006:259). The daily tasks in school involve considerable directionality: writing in the top right hand corner of the page or folding the right side of the paper to the left side. Even getting dressed requires knowledge of directionality, knowing the front from the back, and the left sleeve from the right sleeve and one's own left and right side.

3.6.7 Interhemispheric Integration

The human brain consists of two hemispheres (cf. 2.2.2.1), which function like two networked computers. The left side receives motor and sensory input from the right side of the body and the right side receives input from the left side of the body.

Interhemispheric integration refers to the communication between the left and right cerebral hemispheres of the brain. It entails the coordination of the left with the right side implies the separate functioning of each side as well. Psychologists (Louw, 2009; Keogh & Sugden, 1985) also refer to it as bilateral integration (Figure 3.4).

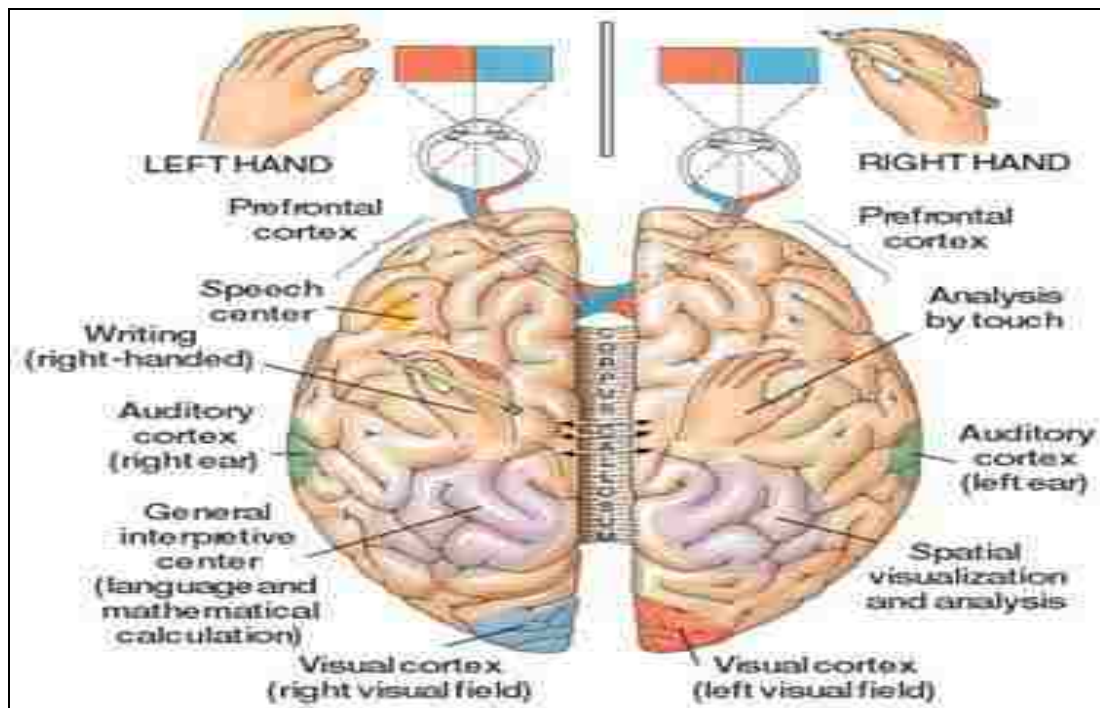


Figure 3.4: Interhemispheric integration

Source: Louw (2009:115)

A summary of the general achievements in the functional development of body knowledge is given in table 3.1. This includes the identification of body parts, laterality, directionality and lateral preference (handedness). This table should only be seen as a guideline and not as a checklist.

Table 3.1: General achievements in the functional development of body knowledge

Age in years	Identification of body parts	Laterality	Directionality	Lateral preference: handedness
0-2	Begins to 'show' major body parts (eyes, nose, ears, hands, feet).			Preference changes during first year, depending on task.
2-5	80 % identify eyes, 50 % identify eyebrows.	Left-right discrimination is not better than chance. At ages 4-5, realise that left and right are on the opposite sides of the body; unsure of which is which.	Very little knowledge of directionality	At ages 3-5 increase in right-handedness.
5-7	At ages 5-6, 70 % identify all major body parts. At ages 7, 70 % identify minor body parts (elbows, wrists, heels).	Consistent in response, whether right or wrong. At age 7, mistakes are infrequent.		
7-12	At ages 8 – 9, mistakes are rare.	Beyond ages 7-8, identify all left and right body parts.	At age 9, can make objective directional references. At age 10, identify right and left of person facing them. At age 12, begin to use natural reference systems.	At ages 9-10. Right-handedness stabilises for about 80 %. Right-eyedness increases. At ages 10-11, right-hand-eye preference increases.

Source: Keogh & Sugden (1985:275)

3.7 AN INTEGRATED APPROACH TO THE BASIC NEUROLOGICAL SUBSYSTEMS AND LEARNING READINESS

As discussed in the previous sections movement and learning are undoubtedly linked. A weakness in motor development has an effect on perceptual adequacy and conceptual development. A relatively minor deficiency in motor learning interferes with a larger area of subsequent and more complex learning. The child who is unable to cross the midline could experience difficulties with handwriting and reading. Problems with spatial awareness might influence his ability to write between the lines. Other aspects, such as laterality and directionality, also have an influence on learning. If the educator can improve the mentioned aspects, the child could experience improved academic success; therefore learning readiness is dependent on a well-functioning neural networking. The assessment and incorporation of motor skills in the curriculum enable the educator to gain insight into the child's level of motor operation. Using a specifically designed movement programme which includes activities for developing the sensory motor system helps the educator to improve the child's learning readiness.

In Chapter 2 of this study, the researcher has illustrated the dynamic interplay between the various subsystems. The vestibular system forms the basis of the visual system as these two subsystems are closely aligned (Goddard, 2002:59). Cognition of functionality of the sensory motor systems is necessary to determine if they are functional or dysfunctional. Cheatum and Hammond (2000:143) illustrate in figure 3.5 which systems are involved when a child is sitting at the desk and writing.



Figure 3.5: Sensory motor activities involved with writing

Source: Cheatum & Hammond (2000:134)

The Holistic Approach to Neurodevelopment and Learning Efficiency (HANDLE) perspective provides a diagrammatical representation (Figure 3.6) of the integrated and interdependency of the subsystem necessary for effective functioning. The chart was developed by Bluestone (2000), the director of HANDLE. This chart illustrates the hierarchical nature of the neurological system and indicates how higher level systems depend on the systems at the lower level. The chart also depicts the hierarchical route of human development from bottom to top. The arrows indicate that the different subsystems support others while being supported by those below them. Systems higher up could also have an effect on the systems below them. It is important to note that no one system can function on its own. A weakness in a subsystem places strain on the entire systems due to their interconnectedness (Van der Westhuizen, 2007:179–181).

Of further importance is that the integrated approach provides possible clues for an intervention programme which should start at the root, and gradually develop and structure the neural networks which support the cortical systems. This same approach is seen in 'The Ladder of Learning' (Figure 3.7) which was developed by Pheloung. Pheloung (2006:39) asserts that since the early finding of Ayres (1979) the role of the sensory motor system on learning, there continues to be growing research that movement and bodywork improve brain function and learning.

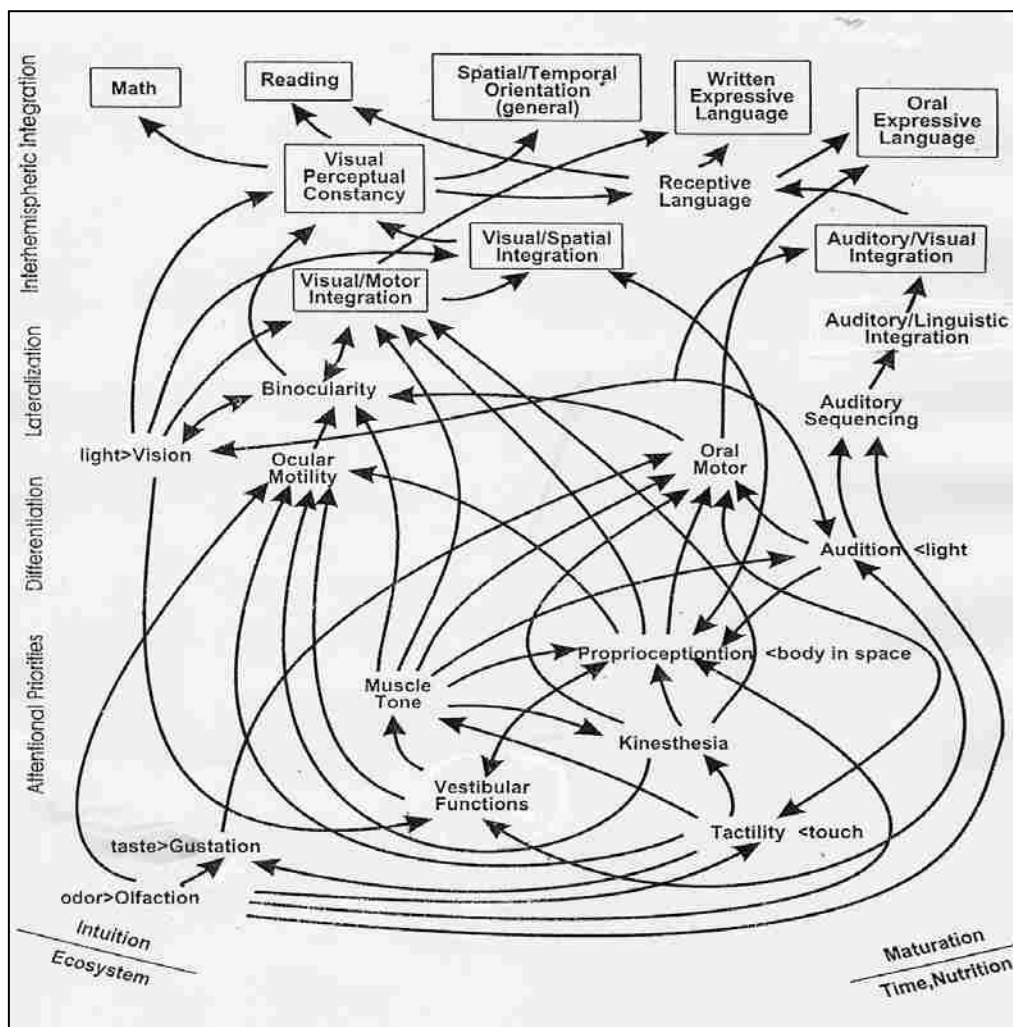


Figure 3.6: Sensory-motor Interdependency and Interaction

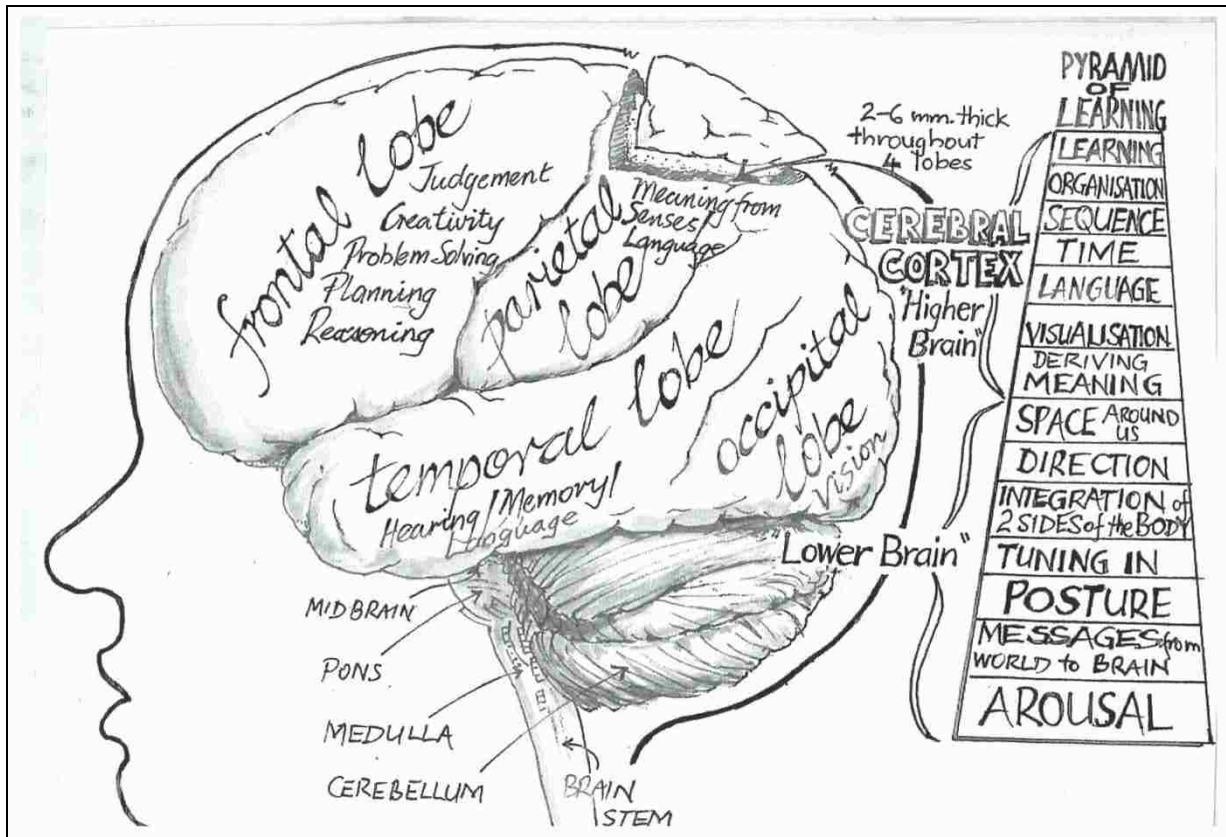


Figure 3.7: The “Ladder of Learning”

Source: Pheloung (2006:2)

3.7.1 The influence of five basic sensory systems on learning

The five basic sensory systems as discussed in chapter 2, which play an important role in the child’s functioning, have to be functional in order for learning to be effective. This means that should one of the systems be dysfunctional it could lead to possible interference in the learning process in and out of the classroom. The systems specified in this study include: Vestibular (Balance system – the main coach of the sensory system), Proprioceptive (Body in space), Tactile (Touch), Visual (Seeing) and Auditory (Hearing) systems. Each has a sensory organ through which information is gained and primary actions are initiated. They depend on each other for interpretation of information and movement. For example, balance is strongly influenced by the vestibular system, but also depends on the other systems. The sensory system begins to develop in utero which is why the foetus has the ability to hear, see, smell, taste, touch and move. At birth the infant is in a state of sensory readiness, ready to learn and to seek information from the environment and the movement of his body (Clark Brack, 2004).

Problems with each system will have repercussions for various areas functioning in the classroom (Goddard, 1995; Cheatum & Hammond, 2000; Kranowitz, 2005). Several symptoms for selected systems are given in Table 3.2.

Table 3.2: Influence of the five basic sensory systems on learning

<p>3.7.1.1 Symptoms of a vestibular problem:</p> <ul style="list-style-type: none"> • reported preference for quiet activities (a couch potato) • complaints of dizziness or nausea • frequent loss of balance • difficulty sitting still • general clumsiness • seeking out spinning activities • avoiding certain movements • a pallid or flushed skin after certain movements • low muscle tone • car sickness • poor directional awareness • difficulties in space perception • poor organizational skills • dizzy behaviour, literally meaning "scatterbrained" 	<p>3.7.1.4 Symptoms of children who are insensitive to touch:</p> <ul style="list-style-type: none"> • Cannot identify body parts • Has poor spatial awareness • Lacks body schema • Lacks desire to participate • Has poor body image • Shows poor posture • Appears clumsy • Is unable to adjust body to the tasks it faces • Does not show refined movements • Seeks physical contact • Has poor motor planning • Has poor balance skills • Has poor gross motor skills • Lacks laterality and directionality • Has poor awareness of left and right • Has trouble finding his way around shopping malls or school • Shows poor motor skills • Has trouble using scissors • Has trouble using crayons • Lacks ability to discern shapes, textures and weights
<p>3.7.1.2 General symptoms of proprioceptive problems:</p> <ul style="list-style-type: none"> • Poor naming and locating of body parts • Poor balance, both static and dynamic • Problems with fine motor skill, cutting, colouring, and so on. • Appears not to know when he is touching others • Uses either hand to write, colour, throw and so on. • Poor posture and muscle tone • Uses either foot to kick • Often hits or moves a body part to "awake it" before moving. • Problems with gross motor skills, such as running and jumping. • Difficulty learning to dress himself • Has splinter skills and can't transfer them to related skills or activities • No left and right awareness • Has no memory of past instructions involving motor skills • Cannot coordinate use of his eyes • Midline problems cause lack of coordination between the two sides of the body. • Cannot use two hands together for skills. • Falls often and has more accidents than other children his age. • Cannot tell directions; gets lost easily. • May run into furniture, walls, or other people. • Has no awareness of up and down, before and after • Immature loco-motor patterns for walking. • Poor awareness of space. • Prefers to play with younger children. • Has trouble finding place in books and on paper. 	<p>3.7.1.5 Common tactile-defensive symptoms seen in the child, on the playground or in the classroom:</p> <ul style="list-style-type: none"> • Dislikes tag games • Avoids somersaults • Hates being hit or tagged with a ball • Avoids most stunts with other children • Avoids sitting on grass or rough carpet squares • Prefers to be alone • Cries when made to get into the water for swimming • Does not like to towel dry • Dislikes tug-of-war games • Socks always feel uncomfortable • Tries to stay at the end of a line of children • Hates having dirt on body or hands • Avoids standing in lines • Does not like rolling • Prefers loose-fitting clothes • Responds with fighting when touched from behind • Responds to someone's touching by hitting • Dislikes contact sports • Complains about certain clothes • Is considered a trouble maker or aggressive
<p>3.7.1.3 Possible visual dysfunctions:</p> <ul style="list-style-type: none"> • Poor eye contact • Turning head to side to read or look at things • Holds head very close to work • Stomach aches after reading or visual work • Difficulty copying from the board • Difficulty tracking a ball to catch • Loses place on page when reading • Blinks eyes a lot • Rubs eyes after visual work 	<p>3.7.1.6 Symptoms of possible auditory dysfunction</p> <ul style="list-style-type: none"> • Covers ears or scream with sudden loud noises • Has difficulty locating sound • Enjoys constantly making sounds (eg. Humming) • Is easily distracted by background noises • Prefers very loud music • Delayed language development • Dislikes crowds and noisy environments • Asking for repetitions of word and conversation • Difficulty falling asleep or staying asleep if there is any noise • Delayed and laborious decoding of reading

Source: Kranowitz (2005); Cheatum & Hammond (2000); Clark Brack (2004); Goddard Blythe & Hyland (1998)

3.8 CONCLUSION

Knowledge of the interdependency of the subsystems is vital for the optimal functioning of the child. Lack thereof leads to ignorance of the role of movement as the basis of all learning and an upside down approach of concentrating on high level functions instead of lower levels functions first.

In the South African context, foundation phase educators need to place more emphasis on the basic building blocks which are considered to lay the foundation for learning readiness. As indicated in this chapter the basic skills have to be taught thus providing children with opportunities to develop their gross motor abilities thereby strengthening the brain's architecture.

Chapter four presents the empirical research design.

CHAPTER 4

RESEARCH DESIGN

4.1 INTRODUCTION

This chapter discusses the research approaches adopted, research design, data collection methods utilized, and data analysis techniques used.

Research involves a systematic process of collecting and logically analysing information (data) for some purpose. There are various methods and approaches of investigating a problem or a research question. Research is also not limited to one approach (McMillan & Schumacher, 2001:8-10). Welman and Kruger (2004:2) acknowledge that research involves the application of various methods and techniques in order for the researcher to create scientifically obtained knowledge by using objective methods and procedures.

4.2 PURPOSE OF THE RESEARCH

The aim of the study was to determine whether movement programmes are a means to learning readiness. This gave rise to the following research questions:

- What was the current motor proficiency level of a chosen group of learners with regards to vestibular, proprioception, muscle tone, tactile, visual and auditory functioning?.
- What was the learner's current state of learning readiness according to his or her current academic level?
- Did the specifically designed movement programme improve motor proficiency as well as the current level of learning readiness?
- Which of the five sensory motor systems of learners were dysfunctional? Were learners better equipped for learning after the implementation of a movement programme?

4.3 HYPOTHESIS

According to Gray (2004:73) a hypothesis is a conjectural statement of the relation between two or more variables. Salkind (2003:7) states that a hypothesis is "an educated guess". It results when the questions are transformed into statements that express the relationships between variables as an "if/then" statement. Considering the literature study discussed in chapter 2, chapter 3 and the primary aim of this research study (movement programmes as a means to learning readiness), I formulated the following hypothesis:

Hypothesis: There is a significant difference between the pre-test and post-test results of a group of learners who participated in a movement programme.

Rationale: From the literature study it was evident that movement is required for the development of lower level functions (vestibular, muscle tone, tactile, proprioception) in order for higher level cognitive functions (i.e., ability to read, write and calculate) to function effectively (cf 3.2).

4.4 RESEARCH METHOD

This research followed a quantitative approach. Research requires the measurement of behavioural outputs (performance) with the use of standard assessment tools which present quantitative criteria. Other aspects incorporated in this study, such as the assessment of the functioning of the vestibular system, were more difficult to measure quantitatively. I did, however, use a scale to indicate quantitative measures utilised (cf 4.5.6.4).

4.4.1 Quantitative research

Marczyk, DeMatteo and Festinger (2005:17) describe quantitative research as involving studies which make use of statistical analyses to obtain findings. It includes formal and systematic measurement and consists of the presentation of statistical results which are presented with numbers. The quantitative approach made it possible for me to determine the learner's level of functioning prior to the implementation of the movement programme as well as the impact of the movement programme on the learner's learning readiness according to post-test results.

4.5 RESEARCH DESIGN

The design of the study is the plan which is to be followed in order to provide answers for the research objectives. A quasi experimental design was selected to obtain data before the implementation of a movement programme as well as to determine the impact of the movement programme (cf 4.5.3).

4.5.1 Selection of the sample

A research problem has bearing on some or other population. According to Welman and Kruger (2004:46), population is the study object, which could be individuals, groups, human products, organisations, events or conditions to which they are exposed. When selecting the size of the population (N) it is sometimes virtually impossible and impractical to include the entire population. The researcher has to rely on data collected from a sample of the population. The participants in this study were selected through convenience sampling. The group of subjects were selected on grounds of being accessible as well as being particularly informative about the topic (McMillan & Schumacher, 2001:175).

The strengths of using the convenience sampling techniques is among other advantages that it is less costly, easy to administrate and assures high participation rate. This sampling technique enabled me to

evaluate learners' current state of motor proficiency and the effect of a movement programme on learners' motor proficiency and learning readiness.

This study took place at a selected primary school in the Gauteng Province, South Africa. The aim of this study was to determine whether movement programmes are a means to learning readiness. From the literature study presented, it is noted that children need certain requirements in order to be learning ready (cf. 3.6). For this reason a specific pre-selected group of children were included in this research. The specific Grade two class had a combination of nine boys and five girls who were experiencing barriers to learning. Some of the barriers which the learners were experiencing were low muscle tone, lack of spatial awareness and coordination, problems with laterality and directionality, midline crossing problems and short attention span, inability to read and spell (communication with class educator). The number in the classroom totalled fourteen ($n=14$). The learners were between the ages of 7 to 9.5 years.

4.5.2 The one-group pre-test-post-test design

The use of control groups reduces the threat of the validity of the results. In this study, however, a one group pretest-posttest design was chosen which allowed for intensive descriptions and analyses, as well as for an in-depth understanding of the researched phenomenon.

4.5.3 Experimental mode of inquiry

The quasi-experimental mode of inquiry was used. This mode is used as it can determine cause and effect if there is direct manipulation of conditions. This means that there was no random assignment of subjects. The class was 'intact' and already organised as a special class. Different teachers were not assigned to the group (McMillan & Schumacher, 2001:32). The group of learners were pre-assigned to the special class on grounds of their academic performance during the first year of school. All the learners as stated were in grade two and were experiencing barriers to learning.

4.5.4 Ethical measures

Marczyk et. al (2005:233) states that virtually all studies with human participants involve some degree of risk. The risks can range from minor discomfort or embarrassment caused by somewhat intrusive questions to more severe effects on participants' physical and emotional well-being. The researcher must be aware that these risks present his or her with an ethical dilemma as to the degree to which participants should be placed at risk in the name of scientific progress. All potential risks and ethical conflicts in the design and conducting research need to be considered. The participants' basic rights were considered at all times during this research. To ensure the protection of the participant's rights, interests and sensitivities, ethical considerations were employed for the duration of the research. For confidentiality reasons each learner was allocated a number according to the alphabetical class list in ascending order, from one to fourteen.

4.5.5 Consent to undertake the proposed research study

The mechanism used to describe the research study to the potential participants and providing them an opportunity to make autonomous and informed decisions whether to participate is *informed consent*. I approached the principal of the school to obtain permission to conduct the inquiry in the school (cf Addendum G). Once this permission was obtained, I approached the class educator (cf Addendum I) and the parents/caregivers respectively to obtain formal consent to proceed with the proposed study (cf Addendum H). The children were too young to sign assent (agreement to participate); therefore only the consent of parents was considered necessary.

4.5.6 Measuring instruments used in the empirical investigation

In order to provide scope to the research and the collectable data, quantitative measuring instruments were included at the pre and post intervention stages of the movement programme. Movement plays a fundamental role in learning. In terms of the hypothesis formulated for this study, the motor proficiency and the functioning of the sensory motor systems of the participants had to be assessed and measured. To test the hypothesis, the subsequent measuring instruments were used.

4.5.6.1 7/8 year old group test

This test was designed with cognisance of the difficulty to measure school readiness. A child's mental aptitude and level of development are the main determining factors of progress at school. Social, emotional and motor maturity also needed to be considered. The test was selected on the grounds of its ability to indicate the general level of a person's intelligence as well as the participant's school readiness. The test consists of six subtests (comparison, mazes, verbal comprehension, figure classification, number comprehension and pattern completion) and a maximum raw score of 50 is attainable (Human Science Research Council, 1989a:35).

4.5.6.2 Bender Gestalt II

The Bender® Visual-Motor Gestalt Test (Bender Gestalt II) measures visual-motor integration skills in children and adults from four to 85+ years of age. It utilizes 16 stimulus designs which examinees have to first copy and then recall from memory. The aim of the test is to obtain more refined measurements of simple motor and perceptual abilities in order to provide the examiner with information of the performance of controlled motor and perceptual tasks (Brannigan & Decker, 2003:10).

A supplement Motor test and a Perception test has been included in the Bender –Gestalt II, which in essence is used to provide the examiner with an additional opportunity for observation of an examinee's performance. It detects deficits in motor and/or perception skills that would adversely affect a subject's performance (Brannigan & Decker, 2003:10). Further use of the Bender Gestalt II is to aid in differentiating between learning, psychological, and neurological problems.

4.5.6.3 Basic scholastic assessment

Basic scholastic assessments were used during the pretesting and post testing stages under the same conditions. The *one minute tests* were selected on grounds of their ability to test the participant's cognitive abilities in the areas of *reading and mathematics (addition and subtraction)*. The tests were originally used during the standardisation of the ISGSA (Individual Scale for General Scholastic Aptitude). The *UCT spelling assessment* was also used to determine the participants spelling ability (University of South Africa, 2005). A summary of the tests used in this study: One minute reading test; One minute mathematics (addition); One minute mathematics (subtraction); and the UCT spelling test (Human Science Research Council, 1996a-c).

4.5.6.4 Movement proficiency assessment

The functioning of the sensory motor system is vital in order for effective learning to take place. Chapter 2 explained the importance of these sensory motor systems and their role in learning readiness. I chose to assess the children on a variety of neurological aspects by setting up a combination of tests in order to evaluate certain neurological aspects. As this was a motor skills assessment, it required me to rely on my own observation. To simplify the scoring I used either (0) indicating not being able to do the activity; or (1) able to perform the activity.

It must be noted that the tests have been used by other researchers as well (Cheatum & Hammond, 2000). The scale used for the presence of retained reflexes was adopted from the Institute for Neuro-Physiological Psychology (Goddard Blythe, 2006b). Included in the table (cf Addendum J) is the total summary of the activities used in the movement proficiency assessment. Considering the nature of the research it must be noted that these are not standardised for the South African context. A brief discussion of the tests used to determine neurological functioning is given below:

a) Vestibular system

Manns test: This test requires the child to stand on a straight line with the heel of one foot against the toe of the other foot. This test is conducted with eyes open and then eyes closed (Cheatum & Hammond, 2000:154-155).

One leg test: The child has to stand on his preferred foot, with the opposite leg bent at the knee and his eyes opened then closed. Repeat this on the non-preferred foot, eyes open and eyes closed (Cheatum & Hammond, 2000:154-155).

Postrotray-nystagmus: This test measures the length of time nystagmus lasts following rotation of the child. The child sits in a chair with his head slightly bent toward the chest. He or she is then rotated ten complete turns in one direction for 20 seconds. Once the rotation has stopped the child's eyes are checked for movement. After a two minute rest the child is rotated in the opposite direction. The examiner must take note of the following: after the rotation, if the vestibular system is functioning

normally the nystagmus will last for seven to fourteen seconds. Anything below is considered hypovestibular (below normal = 0) and anything above is hypervestibular (above normal = 1).

b) Muscle Tone

In order to assess this aspect the child needs to lie down on the back and lift the legs for 10 seconds. If the legs bob up and down it is an indication of poor phasic muscle control (score 0) and if the legs do not bob up and down (score 1), the child has good phasic motor control.

c) Proprioceptive system

It can be difficult to determine the exact location for a proprioceptive system problem. It is possible that it can be anywhere in the entire sensory motor process. Cheatum and Hammond (2000:194-201) give a description of the proprioception tests chosen for this study:

Angel in the snow test: This test is aimed at evaluating if the child's proprioceptive system has or has not developed sufficiently. The child is placed on the back on the floor with the midline along a straight line. The examiner must then give the child an indication of which limbs to move (e.g., both arms and legs, both arms, both legs, left arm). The examiner observes if the learner can follow the instructions (scores 1) or cannot follow the instruction (scores 0).

Rhomberg test: This test requires the child to assume a standing position, with both feet together, the arms relaxed at his side, and the eyes closed. The proprioceptive system is responsible for controlling various parts of the body. The examiner has to observe if the participant can maintain balance (scores 1) or if there is weaving back and forth, lifting or moving of feet, and lifting or moving one or both arms (scores 0).

Reciprocal limitations: The child is requested to imitate the examiner's movements for example, open one hand while closing the other hand, turn the palm of the hand down while the other one is up, raise the one while lowering the other. Observation was made if the child could or could not do the skill using the same side as the examiner. Confusion with regards to left and right is prevalent in this activity.

Index finger-nose test: This is completed standing with both arms raised to shoulder level and extended to straight out to the side. Using the index finger of the preferred hand the child touches the nose then returns the arms to starting position. This is alternated to the non-preferred side as well.

Shoulder-level arm raise test: The test requires the child to close the eyes and raise the preferred arm to shoulder level, placing it there four times in a row. The child has to repeat it with the non preferred arm as well. Varying heights of the arm indicate a problem with body schema.

d) *Tactile system*

The *skin touch tactile awareness* assesment was used to do the evaluation. The child was blind folded. The examiner took a coloured pen and applied light pressure to different parts of the body. The child was asked to indicate where the examiner has touched. Observation had to be made as to the spot which was marked with the coloured pen. A random sequence was used as to confuse the child (Cheatum & Hammond, 2000:231-234)

Object identification test: This test enabled the examiner to test the child's ability to identify an object by feeling it. The child was blind folded and familiar items were placed on the table. The child had to use the hand for identification.

The *traced number identification test* was used to determine if the child could indentify numbers which were traced on various parts of the body. Digits between zero and nine were chosen while the child was blind folded. According to Cheatum and Hammond (2000:235) this is considered a test to determine graphesthesia (the ability to identify figures written on the skin).

e) *Visual system*

The *visual fixation test* was used to check fixation by holding a pencil about 20cm in front of the child's nose. The child is required to look at it for 10 seconds without blinking his eyes or changing the position of his head.

The *binocular fusion test* consisted of asking a child how many pencils are seen when one is held in front of the eyes. The eyes are supposed to fuse the images received from both eyes into a single image.

A *visual tracking assessment* consisted of the examiner holding a pencil in front of the child's nose and moving it horizontally in front of the nose to the other side of the face. The child had to follow the pencil only with the eyes fifteen times. This activity was repeated back and forth fifteen times vertically as well horizontally (Cheatum & Hammond, 2000:279).

f) *Auditory system*

One simple screening procedure was used to evaluate the child for possible auditory problems. The child was required to *tap a sequence* with both hands on the table which the examiner demonstrated. Sequences of 1,2 ; 2,3,2 ; and 3,2,3 were used. The child had to close the eyes for this activity (Cheatum & Hammond, 2000:318).

g) Reflex system

The assessment of the possible retained reflexes (cf chapter 2) was conducted according to selected battery tests with regards to the Asymmetrical tonic reflex (Schilder test), the Symmetrical tonic neck reflex (STNR), the Tonic labyrinth reflex (TLR), the head righting reflex (HRR) and the moro reflex (Goddard Blythe, 1996a:7-11; Goddard, 2002:81-95). The scoring of each reflex is given in the movement screening table (cf Addendum J).

h) Body awareness

A simple test was chosen to determine if the child was knowledgeable about the various body parts. This is known as the *body concept* test which required the child to point to the body part that was called out (Cheatum & Hammond, 2000:93).

4.5.7 Procedure of data collection

4.5.7.1 Procedure

The procedure followed in order to prepare, conduct pre tests, provide intervention and final collection of data included the following: (1) Initial contact with the school principal and permission (cf Addendum G); (2) Discussion with the educator and obtaining permission from the educator (cf Addendum I); (3) Permission letters to parents (cf Addendum H); (4) Pretesting conducted at school in an individual setting; (5) Training of the educator of the class (6) 10 week movement programme; and (7) Post testing conducted at school in an individual settings.

4.5.7.2 Movement programme

The movement programme was designed to incorporate all possible activities to develop the sensory motor systems which form the basis of learning (cf 4.5.6.4). I studied numerous neurological movement based programmes which are currently offered worldwide: HANDLE (Holistic Approach to Neurodevelopment and Learning Efficiency), the Institute for Neuro-Physiological Psychology (INPP) reflex programme, the Move to Learn programme and the CAN LEARN programme.

The movement programme for this study was designed for a ten week implementation period and was offered for 30 minutes a day. I compiled the activities to suit the needs of the group which were determined after pre testing. It was based on the developmental sequence of movements through infancy, vestibular functioning, proprioception, crossing the midline, laterality, directionality, interhemispheric integration, integrating reflexes, muscle tone, tactility, visual activities (divergence, convergence & accommodation) and auditory development. It was necessary to start on a broad neurological development of movement which included the above-mentioned preceding aspects. The educator of the class was present with all the lessons while I attended the lessons twice weekly.

The educator also concentrated on a variety of visual activities (5 minutes daily) in the class separate to the 30 minute movement programme. The programme was set up in a station format with five stations offered during the 30 minutes. The class first did a warm up activity, after which they were divided into groups. They rotated from station to station on the signal of the educator. The learners spent an average of five minutes at each station before being signalled to move to the next station. At the end of the lesson the group did one or two activities as a cool down activity.

The movement programme was divided into various sections. Week 1 - week 3 were kept more or less the same in order for the children to build a good basis. Thereafter, the programme was made a bit more difficult (week 4 – week 6). Week 7 – 8 built on the previous two weeks while week 9 – 10 saw a further degree of difficulty. Additional class activities were added to reduce possible boredom and supply children with a break between academic activities. The detailed programme appears in table 4.1.

Table 4.1: Detailed movement programme: Week 1 – 10

<p>Week 1 – 3 (Stations)</p> <ul style="list-style-type: none"> • Heel toe walking forwards & backwards on rope • Stepping over rope crossing midline • Rolling • Climb through a series of hoops • Clapping game <p><i>Cooling down all in one group</i></p> <ul style="list-style-type: none"> • Clapping game • Rhythm skipping <p>Class activity</p> <ul style="list-style-type: none"> • Eye activities • Crumple papers 	<p>Week 4 – 6 (Stations)</p> <ul style="list-style-type: none"> • Walk on balance beam • Rolling & gliding • Stepping onto chair stepping off chair • Roll back & sit up • Clapping game (integrate left & right) <p><i>Cooling down all in one group</i></p> <ul style="list-style-type: none"> • Rhythm skipping • Speed stacking relays <p>Class activity</p> <ul style="list-style-type: none"> • Eye activities • Speed stacking
<p>Week 7 -8 (Stations)</p> <ul style="list-style-type: none"> • Rolling, gliding & leopard crawl, flip flops • Hoop series • Beanbag throws • Speed stacking (4 x 3 stacking clap before up & down stacking) • Walk on low beam and step over bean bag carry on walking <p><i>Cooling down all in one group</i></p> <ul style="list-style-type: none"> • Clapping game • Rhythm skipping <p>Class activity</p> <ul style="list-style-type: none"> • Eye activities • Tactile activities 	<p>Week 9 – 10 (Stations)</p> <ul style="list-style-type: none"> • Rolling, gliding, leopard crawl, flips flops crawling, rocking, cross pattern walking • Beanbag throws • Speed stacking (4 x 3 stacking clap before up & down stacking , move to other side of table to complete down stack) • Walking on low beam forwards and backwards Climbing over a low pole <p><i>Cooling down all in one group</i></p> <ul style="list-style-type: none"> • Rhythm skipping • Speed stacking relays <p>Class activity</p> <ul style="list-style-type: none"> • Eye activities • Tactile activities

4.5.8 The interpretation of the data

All tests were hand scored. The manuals for the 7/8 year old group test, the Bender Gestalt and the basic scholastic tests were used to score each specific test. The motor proficiency assessment was scored according to the score sheet which has been included (cf Addendum J). The data were scored for both pre and post tests respectively.

In order to interpret the data, all scores had to be transferred onto the consolidated scoring sheet which was designed specifically for this study (cf Addendum K). Care was taken that the scores were correctly copied which meant it was checked by two persons before finalisation could take place. The scoring sheets had been divided into various sections in order to make the interpretation thereof more structured.

The data had to be interpreted and meaning conveyed. The pre and post tests scores were compared in order to determine if the learners showed any improvement in their current level of academic functioning as well as in their motor proficiency levels. The data gave an indication of which sensory systems were dysfunctional and needed further attention. The levels of movement proficiency provided an indication of the learner's learning readiness as this correlated with the requirements mentioned in section 3.6. McMillan and Schumacher (2001:414) indicate that the findings enabled others to understand similar situations and to apply these findings in subsequent research.

4.6 CONCLUSION

In this chapter, the planning and the execution of the empirical investigation were discussed. The discussion of the various measuring instruments and the procedure of data collection used in the empirical investigation were given. This section included the movement programme which was aimed at improving the academic functioning and the motor proficiency levels of the learners.

Chapter 5 will deal with the statistical processing and interpretation of the data.

CHAPTER 5

RESULTS OF THE EMPIRICAL INVESTIGATION AND INTERPRETATION

5.1 INTRODUCTION

The main objective of this study was to develop a movement programme that could be used as a means to learning readiness. Based on this objective the hypothesis stated in chapter 4 (cf 4.3) was formulated. To statistically test the hypothesis, basic statistical techniques were applied to the data obtained from the pre and post testing.

The movement programme was followed for 30 minutes a day for a period of ten weeks. I was present twice a week at the movement programme presented on that particular day. The educator and I consulted on a regular basis for the duration of the research project.

5.2 DATA PREPARATION

In every type of research endeavour, data about the topic should be collected and analysed to test the viability of the hypotheses (Salkind, 2003:148). In this research, in order to prepare the data for the statistician, the same procedure for the pre and post testing was followed. The score sheets were completed for the 7/8 year old group test, the Bender Gestalt II (Motor and perception supplementary test), the basic scholastic assessment tests, and the Motor proficiency test for both the pre and post tests. The data were coded specifically to include the raw scores of the above mentioned tests as well as biographical detail. The raw scores were then transferred to the specially designed data collection forms which were completed by hand (cf. Addendum K). These forms were scrutinised three times for any possible errors.

Parametric and nonparametric paired difference tests were performed on the score-differences of the respondents. The SAS (Statistical Analysis System), version 9.3.1, statistical package was used to this end. The Proc Univariate procedure calculated the required paired difference t-test statistic and associated t-probability for the parametric approach and the Wilcoxon Signed Rank test statistic and associated probability for the nonparametric approach. The probabilities obtained in this way were compared against the general 1% and 5% level of significance to decide whether pre-and post-treatment levels differed significantly.

5.3 DESCRIPTION OF PARTICIPANTS

The Council of Learning Disabilities (CLD) Research Committee (1993:212) states that in order to achieve external validity for other researchers to replicate the study, a description of the participants who took part in the research study should be given. A description is given in Table 5.1.

Table 5.1: Description of participants

Numbers:	
Boys	8
Girls	6
Age	
Mean	8.07
Race/ethnicity numbers:	
White	10
Black	3
Coloured	1
Social Economic Status:	
High	0
Middle	10
Low	4
Grade Level:	
Time in Special Education Placement	Participants were placed in the special class in January 2010
Level of placement	All the participants are currently in Grade 2
Location: Geographic region	
Urban	All participants are resident in an urban area

5.4 TESTING THE HYPOTHESIS

5.4.1 The null hypothesis

With regard to the Hypothesis formulated in section 4.3, the following null hypothesis was formulated:

H₀: *There is no significant difference between the pre test and post test results of a group of learners who participated in a movement programme*

In order to test the null hypothesis the scores of each learner for the pre-tests were compared with that of the post-test scores. These scores were obtained from the selected battery of tests, namely:

- IQ 7/8 Year Old group test
- Bender Gestalt II : (Motor and Perception supplementary tests)
- Basic Scholastic Assessment : (One minute reading test, one minute mathematics test in addition & subtraction and the UCT spelling test)
- A Movement Proficiency Assessment: (Vestibular, Muscle Tone, Proprioception, Tactile, Visual, Reflexes, Auditory, and Body awareness).

The data obtained from the sample group of fourteen learners were analysed to determine whether the null hypothesis was rejected or accepted. This entailed the calculation of mean scores for each of the tests and sub-tests and then t-test scores. The mean is simply the arithmetic average of all the scores. The t-test is the most common statistical procedure in order to determine the level of significance when two means are compared (McMillan & Schumacher, 2001:215 & 369).

When the sample is large enough ($N > 30$) the t-test can be used to analyse data, irrespective of the distribution of the population (Ferguson, 1981:160-161). Since the sample is only 14 in this instance, the distribution of the population must be taken into account. One cannot be absolutely sure whether the population has a normal distribution with regard to all the variables measured in the present design.

According to Mulder (1993:158), non parametric tests are used when the researcher is not sure whether the distribution of the population is normal or not. It was therefore decided to use a parametric test (t-test) and a non-parametric test (Wilcoxon Signed Rank test) to analyse the data. However, the same results were obtained in both analyses. Consequently only the t-test analysis will be discussed.

5.4.2 Results of the tests

The results of the pre-testing of the learners before the movement programme was implemented are given in Table 5.2.

Table 5.2: Pre-test: The mean and standard deviation of the different variables

Variable	Mean	Standard Deviation
IQ – 7/8 year old group test	84.71	10.43
Motor	11.14	0.86
Perception	9.86	0.36
1 Minute: Addition	7.05	0.33
1 Minute: Subtraction	6.96	2.05
UCT Spelling Test	8.08	0.62
1 Minute: Reading	7.35	0.62
Vestibular	1.07	1.33
Muscle Tone	0.64	0.50
Proprioception	9.64	3.03
Tactility	11.07	1.38
Visual	2.29	1.68
Reflexes	10.14	2.26
Auditory	0.21	0.42
Body Awareness	10.07	0.83

N = 14

The standard deviation indicates the average variability of the scores. This is the distance of the average of the scores from the mean (McMillan & Schumacher, 2001:221). The movement programme described in chapter 4 (cf 4.5.7.2) was followed for ten weeks after which the learners were again tested. The results obtained from this post testing are given in Table 5.3.

Table 5.3: Post-test: The mean and the standard deviation of the variables

Variable	Mean	Standard Deviation
IQ 7/8 year old group test	83.86	10.45
Motor	10.43	1.87
Perception	9.93	0.27
1 Minute: Addition	7.72	0.73
1 Minute: Subtraction	8.00	0.71
UCT Spelling Test	8.72	0.91
1 Minute: Reading	8.28	0.97
Vestibular	3.71	1.07
Muscle Tone	0.86	0.36
Proprioception	14.93	2.09
Tactility	10.14	0.53
Visual	4.14	1.29
Reflexes	4.79	2.26
Auditory	1.93	0.27
Body Awareness	10.43	1.16

N =14

The t-test for dependent groups was then applied to the data in order to determine if the differences between the pre-test and post-test results were statistically significant. These t values, the probability of rejection or acceptance at the 0.01 or 0.05 levels as well as the difference in means are given in Table 5.4.

Table 5.4: The difference between the means of the variables, t-scores and probability

Variable	Difference between Means	T value	Probability
IQ 7/8 year old group test	-0.86	0.45	p>0,05
Motor	-0.71	1.33	p>0,05
Perception	0.07	0.56	p>0,05
1 Minute: Addition	0.67	3.85	p<0,01
1 Minute: Subtraction	1.05	1.91	p>0,05
UCT Spelling Test	0.64	3.30	p<0,01
1 Minute: Reading	0.93	4.39	p<0,01
Vestibular	2.64	7.74	p<0,01
Muscle Tone	0.21	1.38	p>0,05
Proprioception	5.29	4.61	p<0,01
Tactility	-0.93	2.51	p<0,05
Visual	1.86	4.19	p<0,01
Reflexes	-5.36	6.68	p<0,01
Auditory	1.71	13.68	p<0,01
Body Awareness	0.36	1.44	p>0,05

N = 14

5.5 ANALYSIS OF TEST RESULTS

When comparing the mean scores of the two sets of tests results, it is noted that in general the averages were higher in post-tests than in the pre-tests. The scoring of the tests would be that the higher the degree of learning readiness, the higher the scores. A higher mean in the post test could thus mean an increase in the level of learning readiness. However, the exception would be with the scores for reflexes and muscle tone. It must be noted that the means for Reflexes for post-testing (Table 5.1) was lower than the pre-test score (Table 5.2). This does not mean the learners did not improve after the implementation of the programme. The tests used for reflexes (cf 4.5.6.4 & cf Addendum J) are such that a higher score represents reflexes not yet inhibited and a lower score represents reflexes that have been inhibited. The idea is to have a lower score which is the case in the post-test data.

When looking at the t-values given in table 5.3, the null hypothesis is rejected for the following variables:

- the One Minute Mathematics: Addition (t-value = 3.85 with $p < 0,01$),
- the UCT Spelling Test (t-value = 3.30 with $p < 0,01$),
- One Minute Reading (t-value = 4.39 with $p < 0,01$),
- Vestibular functioning (t-value = 7.74 with $p < 0,01$),
- Proprioception (t-value = 4.61 with $p < 0,01$),
- Tactility (t-value = 3.85 with $p < 0,05$),
- Visual functioning (t-value = 4.19 with $p < 0,01$), and
- Reflexes (t-value = 6.68 with $p < 0,01$).

In the following instances the null hypothesis is accepted:

- IQ 7/8 year old group test (t-value = 0.45 with $p > 0,05$),
- Bender Motor test (t-value = 1.33 with $p > 0,05$),
- Bender Perception Test (t-value = 0,56 with $p > 0,05$),
- One Minute: subtraction (t-value = $p > 0,05$),
- Muscle Tone (t-value = 1.38 with $p > 0,05$) and
- Body awareness assessment (t-value = 1.44 with $p > 0,05$).

As pointed out previously (cf 2.3.1), the adequate functioning of a lower level system, namely the vestibular system has the most influence on the daily functioning of the child (Kokot, 2006:53-55; Seaman et al., 2003:51). This could subsequently be the effect of the movement programme on significant results with regards to the difference between the means: Vestibular (t-value = 2.64), Proprioception (t-value = 5.29) and Reflexes (t-value = 5.36). It is noted that no significant difference is indicated in the Bender Gestalt II (Motor & Perception tests) with t-values 1.33 and 0.56 respectively. These particular tests focus mainly on the fine motor and visual perceptual development respectively. Chapter 2 (cf 2.4) points out that coordination develops through three basic levels, namely reflexes,

gross motor and fine motor. Looking at the mentioned results the learners still have to develop considerably more in gross motor before the fine motor will improve. Muscle tone on the other hand depends on the vestibular system generating adequate muscle tone (Van der Westhuizen, 2007:158). It is thus possible that the amount of vestibular activities included in the programme might not have been enough and the ten week movement programme should have been extended with a few weeks to improve the muscle tone.

5.6 INFLUENCE OF VARIABLES

It is necessary to mention variables which could possibly have influenced the results of the study. These are discussed in this section:

- Neurological development in each child does not take place at the same time (cf chapter 2 & 3). Each child reaches milestones at his or her own pace.
- Maturation could also have influenced the results. It is referred to as changes that are due to natural development, which may threaten the internal validity of a study (Salkind, 2003:308). These changes could be biological or psychological forces.
- The sensory systems also develop according to a hierarchical order. According to Kokot (2003:15), for a child to experience success in learning, a number of sensory-motor systems need to be functioning well. The results which do not show a significant difference could be a result of the aforementioned aspect. It could also relate to disorganisation before reorganisation which, according to Van der Westhuizen (2007:319), is common in sensory integration interventions.
- Other possibilities which could have influenced the results are the effect of the programme over a short time and the absence of a control group.
- Another aspect which could also have had an influence on the findings is the Individual Education Programme (IEP) each child was currently following in the special class. The class educator indicated that each learner receives additional assistance with certain aspects with which they experience difficulty in smaller groups of three to four (communication with teacher).

5.7 CONCLUSION

According to the results of the t-test in the different sub-tests the hypothesis is rejected. It is likely that the movement programme was the variable that contributed to the higher mean scores and the significant t-values. However, the significant results that were obtained must be considered with caution because of the size of the sample (n=14).

Caution should also be applied because movement and learning readiness comprise a number of factors. The battery of test did not include all these factors that are at play but some of these were discussed during the course of the research. Since the empirical inquiry was conducted as part of a

dissertation of limited scope, not all the various factors which could influence movement and learning readiness could be tested.

In addition, movement is a difficult construct to evaluate using objective standardised measuring instruments. Significant improvements, however, were found by the educator in the classroom. The learners showed improvements in various areas such as crossing the midline, laterality, directionality, spatial awareness, concentration, handwriting ability and language ability. Some of these aspects are considered to be abilities which will only improve once the functioning of the lower systems has taken place; for example, spatial awareness and body awareness are reliant on the effective functioning of the vestibular system.

The results of this research correlate with that of other studies conducted on the effect of movement on learning. Fredericks et al. (2006:33-41) found similar significant differences in the pre-test and post-test results in the academic skills in Grade one learners after the implementation of a movement programme. Likewise, in a study conducted by Van der Westhuizen (2007:354-355) a significant difference in the levels of concentration of children after the implementation of a movement programme was also found.

The possibility that some learners have so far entered the school setup with a lack of movement experiences (cf chapter 3 section 3.2) may have lead to the shortage of synapses in the brain which are required for maturation of mental capacities. This is an aspect which needs further investigation using a larger sample of the population.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 INTRODUCTION

The principal objective of this study was to determine whether movement programmes are a means to learning readiness. Research conducted by Bluestone (2004) and Fredericks et al. (2006) has shown that movement plays an important part in the holistic development of the child and is critical for academic learning, performance and competence. In this final chapter the conclusions and recommendations are presented as follows:

- Findings from the literature study.
- Findings from the empirical research.
- Educational implications and recommendations.
- Contributions of this research.
- Limitations of this study and recommendations for further research.

6.2 FINDINGS FROM THE LITERATURE

The literature study was undertaken in order to determine:

- What is the neurodevelopment basis of human movement, the sensory system and the reflex system?
- What is the link between moving and learning and what essential learning takes place through movement?
- Which basic sensory systems are most vital for learning?

A literature study in chapter 2 shed light on the complex nature, structure and functioning of the brain (cf 2.2). It is imperative to take cognisance of the intricate relationship between the brain and the body as it has implications for the cognitive development of the child. Owing to the complexity of the entwinement researchers have pointed out that the healthy development of the sensory systems are crucial to learning readiness (cf 2.3). Problems in this area of development have proved to impact academic achievement (Kokot, 2006:51). The inclusion of the literature study regarding the role of reflexes provided insight as to how reflexes form the initiators of movement patterns which are required for learning (see section 2.4). An in-depth study on the mentioned aspects provides the underlying building blocks which are considered to be important in the child's general neurological development.

The literature study highlighted the neurological development of the child as an important milestone for movement and learning. Karp and DePauw (1989) point out the need to understand which systems are considered early maturing (Vestibular, proprioception & tactile) and which are later maturing systems

(Visual & auditory). This maturation goes hand in hand with motor development which follows a sequential pattern (cf 2.5) and thus in turn influences the child's readiness to learn.

A further literature study in chapter 3 emphasised the need for educators to take cognisance of the early opportunities in the developmental building processes (cf 3.2). Studies show that movement forms an integral part of mental processing thus making it a vital link between learning and the child's degree of learning readiness. Movement is responsible for various essential prerequisites which need to be in place before the child is considered to be learning ready (cf 3.5).

The above mentioned aspects led to the second element of this study, an empirical investigation. The empirical investigation was carried out to determine:

- What the current motor proficiency level of a group of learners was with regards to vestibular, proprioception, muscle tone, tactile, visual and auditory functioning?
- What the learners' state of learning readiness was according to their current academic level with regards to the one minute maths, one minute reading, the 7/8 group tests and the Bender Visual-Motor Gestalt Test?
- Which of the five sensory motor systems of learners were dysfunctional and after the implementation of a movement programme was there a difference?
- Did a specifically designed movement programme improve their motor proficiency as well as their current level of learning readiness?

6.3 THE FINDINGS FROM THE EMPIRICAL STUDY

The empirical study was completed in chapter 4 to statistically test the hypothesis relating to the specially designed movement programme in which a group of 14 learners participated (cf 4.3). The results of the pre-test and post-test data of the empirical investigation provided constructive assistance in understanding the impact of the movement programme on the degree of learning readiness (cf 5.3). Significant results were observable in the functioning of the vestibular, proprioceptive, tactile, visual, reflex, and auditory systems.

6.4 EDUCATIONAL IMPLICATIONS AND RECOMMENDATIONS

Movement forms the basis of all development and is considered a vital key to learning readiness. Moreover, movement plays a critical role in learning readiness, early academic achievement as well as in the neurological development of the child (cf. Chapter 2 & 3). The majority of educators, parents and learners, however are unaware of the role movement plays in facilitating the learning process (cf. 3.5). The fact that the modern child is becoming increasingly sedentary in daily functioning highlights the gravity of providing a movement programme which could enhance his or her current state of learning readiness and cognitive abilities (cf. 3.4). An appropriate understanding of movement, firstly, is to

facilitate the development of the building blocks on which later learning is built. Secondly it serves as an effective tool to enhance essential learning.

It is recommended that the pivotal role of movement in the neurological development of the child be emphasised in schools. More time should be set aside for daily movement programmes which will help improve the child's degree of learning readiness and assist the educator in providing optimal learning experiences for the developing child. It is also suggested that as part of the initial educator's training more emphasis be placed on the importance of movement as well as upgrading the knowledge of current educators by means of workshops.

The focus in the preschool should move away from monotonous paper work and focus more on the motor development of the child. The reason is that primary school teachers are faced with a large number of children with inadequate gross motor abilities (e.g. crossing midline, lack of laterality & directionality) which impact negatively on learning (cf. Chapter 3). Children already in the education system as was the case in this research can also be included in a movement programme. Experiencing success in movement will not only impact on the cognitive functioning of the child but most likely contribute to a ripple effect which may also spill over in emotional well-being.

6.5 CONTRIBUTIONS OF THE RESEARCH

This research study of limited scope contributes, firstly, to providing an understanding of the phenomenon of movement, learning readiness and the importance thereof for the child. The main organ of the body, namely the brain, relies on the body and movement to provide sensory input and output which provides for its optimal development. The early years provide ideal opportunities for their early learning experiences which cannot be left to chance. Denying opportunities for movement can result in faulty brain circuitry which effects later brain development and learning readiness (cf 3.2).

Secondly, the research indicated significant differences in the pre-test and post-test results after a specially designed movement programme was implemented within a limited period of time as part of the school curriculum (see chapter 4). This enabled the participating learners to show an improvement in their degree of learning readiness. It also provided an opportunity for the learners to benefit from their involvement in the programme within the classroom setup to help them function more effectively.

6.6 LIMITATIONS OF THE RESEARCH STUDY AND RECOMMENDATIONS FOR FURTHER RESEARCH

In addressing the research problem, this study's principal aim was to determine if movement programmes are a means to learning readiness. Although this research, as part of a dissertation of limited scope, achieved a great deal, aspects remain which require further attention.

- The first aspect of limitation was the actual sample size. This one group study, which was limited to 14 learners, cannot be considered to be representative of the total diverse population of South Africa. According to Mulder (1993:59), caution needs to be applied when drawing generalised conclusions. The findings of this study can, however, provide directions for future research on this topic. Although this sample study was adequate, it is suggested that a larger sample be considered as well as a control group. Moreover, a sample of preschoolers could be selected for a similar study.
- A second aspect of limitation was the consideration of the learner's neurological maturation. Not all children develop at the same rate and at the same time, as pointed out in chapter 3. The impact of certain historical indicators of neurodevelopmental delays could also have been included in this study (Goddard, 2002:89). These indicators provide insight into possible further aspects inhibiting the degree of learning readiness. The researcher is therefore not sure if improvement is due to normal neurological development or other variables. It is also suggested that the programme be implemented over a longer period of time.
- A third limitation was the consistency in the presenter of the movement programme which could have had an influence on the empirical results. I was present twice a week during the presentation of the programme during 30 minute sessions. The learners might have wanted to impress me in my presence. It is therefore suggested that a neutral person be in charge in this case, only the educator.
- A fourth limitation of this study is the current availability of battery of standardised movement tests and suitable norms which are suited for the South African context. It is suggested that research be conducted to address this aspect.
- A fifth limitation of this study is that more attention should be given to possible emotional components that may influence the results.

6.7 FINAL REMARKS

It was never the intention of the research to reinvent the wheel, but rather to highlight the importance of movement programmes as a means to preparing the child for learning. Despite the limitations of this study, it nonetheless generated useful information and a movement programme which can contribute to clearer understanding of the role of movement in helping a child achieve a certain degree of learning readiness. It also highlights the need for South African higher education institutions and schools to reconsider the importance of movement programmes as a means to learning readiness in current teacher education programmes as well as knowledge regarding the importance of movement in the neurological development of learning readiness.

BIBLIOGRAPHY

Ayres, AJ. 1979. *Sensory integration and the child*. California: Western Psychological Services.

Brannigan, GG & Decker, SL. 2003. *Bender Gestalt II Examiner's Manual*. Itasca, Illinois: Riverside Publishing.

Brannigan, GG & Decker, SL. 2003. *Bender Visual-Motor Gestalt Test*. Second Edition. Itasca, Illinois: Riverside Publishing.

Bluestone, JP. 2004. *HANDLE. Intervention in the holistic approach to neuro-development and learning efficiency*. Second Experimental Edition. June. Seattle: HANDLE Institute.

Bluestone, JP. 2000. Disorders: Attentional Deficit Disorder. Available at: <http://www.handle.org/isorders/add.html>. Accessed: 14/04/2006.

Brotherson, S. 2006. Understanding physical development of young children. Available at: www.ag.ndsu.edu. Accessed: 23/05/2006.

Burn, R. 2005. Learning connections to reading skills by creeping and crawling. Available at: <http://learningconnections.org.uk/2005/11/learning-connections-to-reading-skills.html>. Accessed: 31/07/2006.

Burn, R. 2007. Anatomy of a problem. Reading and language difficulty. Available at: <http://www.theautismcentre.co.uk/reading-and-autistic-child.html>. Accessed: 18/07/2007.

Calitz, E. 1997. Why do children move? *SA Journal of Preschool Education* 22(1): 34-38.

Carter, M. 2002. Moving teachers to move children. In *Child Care Information Exchange*. Available at: http://mail.ccie.com/catalog/product_info.php?products-id=5009746. Accessed: 25/11/2003.

Central nervous system. 2009. Available at: http://en.Wikipedia.org/wiki/Central_nervous_system. Accessed: 14/03/2009.

Cheatum, BA & Hammond, AA. 2000. *Physical activities for improving children's learning and behaviour*. Champaign, IL: Human Kinetics.

Clark Brack, J. 2004. *Learn to move, Move to learn! Sensorimotor Early Childhood Activity Themes*. USA: Autism Asperger Publishing Company.

Corso, M. 1993. Is developmentally appropriate physical education the answer to children's school readiness? *Colorado Journal of Health, Physical Education, Recreation and Dance*, 19 (2): 6-7.

- Council of Learning Disabilities (CLD) Research Committee. 1993. Minimum standards for the Description of Participants in Learning Disabilities Research. *Journal of Learning Disabilities*. April 1993. 6(4):210-212.
- Cratty, BJ. 1972. *Physical expressions of intelligence*. Englewood Cliffs, New Jersey: Prentice-Hall, Inc.
- Cratty, BJ. 1973. *Movement, behaviour and motor learning*. London: Henry Kimpton.
- De Jager, M. 2009. *BabyGym. Brain and body gym for babies*. Welgemoed, South Africa: Wetz Press.
- Delacato, CH. 1959. *Treatment and prevention of reading problems. The neuro-psychological approach*. Springfield, Illinois: Charles C Thomas.
- Delacato, CH. 1970. *A new start for the child with reading problems. A manual for parents*. Springfield, Illinois: Charles C Thomas.
- Delacato, CH. 1974. *The diagnosis and treatment of speech and reading problems*. Springfield, Illinois: Charles C Thomas.
- Delacato, CH. 2006. Neurological Theory. Available at: <http://www.delacatonet/NeuroTheorynew.html>
Accessed: 31/07/2006.
- Department of Education. 2002a. *Revised National Curriculum Statement Grades R-9 (Schools). Life Orientation*. Pretoria: Department of Education.
- Department of Education. 2002b. *Revised National Curriculum Statement Grades R-9 (Schools) Policy Overview English*. Pretoria: Department of Education.
- Department of Education. 2003. *Revised National Curriculum Statement Grades R-9 (Schools). Teachers Guide for Development of Learning Programmes Policy Guidelines*. Pretoria: Department of Education.
- Diamant-Cohen, B. 2007. First day of class. The public library's role in "School Readiness". *Children and Libraries*, Spring Issue: 40-48.
- Eastman, W. 1997. Active living: Physical activities for infants, toddlers and preschoolers. *Early Childhood Journal*, 24(3):161-164.
- Eklind, D. 2008. What is School Readiness? *ExchangeEveryDay*, July 21:1-2.

- Eliot, L. 1999. *What's going on in there?* New York: Bantam Books.
- Espenschade, AS & Eckert, HM. 1980. *Motor development*. London: Charles E Merrill Publishing Company.
- Ferguson, GA. 1981. *Statistical analysis in psychology and education*. London: McGraw-Hill.
- Fontaine, NS, Torre, DL & Grafwallner, R. 2006. Effects of quality early care on school readiness skills of children at risk. *Early Childhood Development and Care*, 176(1):99-109.
- Fredericks, CR, Kokot, SJ. & Krog, S. 2006. Using a development movement programme to enhance academic skills in grade 1 learners. *South African Journal for Research in Sport, Physical Education and Recreation*, 28 (1): 29-42.
- Gagen, LM & Getchell, N. 2006. Using 'constraints' to design developmentally appropriate movement activities for early childhood education. *Early Childhood Education Journal*, 34(3): 227-232.
- Gallahue, DL. 1993. *Developmental physical education for today's children*. Dubuque: WMC Brown.
- Gallahue, DL, Werner, PH & Luedke, GC. 1975. *A conceptual approach to moving and learning*. New York: John Wiley & Sons, Inc.
- Gallahue, DL & Donnelly FC. 2003. *Developmental physical education for all children*. Champaign, IL: Human Kinetics.
- Goddard Blythe, SA. 2000. Early learning in balance. Priming the first ABC. *Support for Learning*, 15(4): 154- 158.
- Goddard Blythe, SA. 2006a. *Developmental exercise programme. For use in physical education classes for children with special needs*. Chester: The Institute for Neuro-Physiological Psychology (INPP).
- Goddard Blythe, SA. & Hyland, D. 1998. Screening for neurophysiological dysfunction in the specific learning difficulty child. *The British Journal of Occupational Therapy*. 61(10):459 – 464.
- Goddard Blythe, SA. 2006b. The INPP School Programme. The Institute for Neuro-Physiological Psychology. Available at: <http://www.inpp.org.uk>. Accessed: 02/05/2006.
- Goddard, SA. 1995. The role of reflexes in the development of the visual system. *Journal of Behavioural Optometry*, 6(2):31-35.

- Goddard, SA. 2002. *Reflexes, learning and behaviour. A window into the child's mind*. Eugene Oregon: Fern Ridge Press.
- Gray, DE. 2004. *Doing research in the real world*. London: SAGE Publications.
- Hager, T. 2006a. An Introduction to Neurodevelopment. Available at: <http://www.kidscanlearn.net/Neuro.html>. Accessed: 13/08/2007.
- Hager, T. 2006b. The eyes must work together. Available at: <http://www.kidscanlearn.net/vision.htm>. Accessed: 13/08/2007.
- Hall, D. 2005. *The human body*. London: Grange books.
- Hannaford, C. 2005. *Smart moves. Why learning is not all in your head*. Salt Lake City, Utah: Great River Books.
- Hansford, PK. 1992. Motoring competence, behavioural confidence and classroom function. *The pre-school years*, 22:28-35.
- Hengstman, JG. 2001. *Movement ABCs. An inclusive guide to stimulating language development*. Champaign, IL: Human Kinetics.
- Henning, E. 2004. *Finding your way in qualitative research*. Pretoria: Van Schaik Publishers.
- How we hear - Journey to cochlear implants. Available at: <http://www.medelcom/US/Journey-to-Cochlear-Implants/Hearing-Loss/The-Anatomy-of-the-ear>. Accessed: 15/07/2008
- Human Science Research Council. 1989a. *Educational and Psychological Test Development Group (EPTES). Manual for the Group test for five and six year-olds and for seven and eight year-olds*. Pretoria: J.C. Insto-Print.
- Human Science Research Council. 1989b. *Educational and Psychological Test Development Group (EPTES). Group Test for seven and eight year-olds*. Form 210. Pretoria: J.C. Insto-Print.
- Human Science Research Council. 1993. *Revised Norms for the Group test for 7/8 year olds*. Compiler: N.C.W. Claassen. Pretoria: Human Sciences Research Council.
- Human Science Research Council. 1996a. *One minute reading test*. Pretoria: Human Science Research Council.
- Human Science Research Council. 1996b. *One minute mathematics (addition)*. Pretoria: Human Science Research Council.

- Human Science Research Council. 1996c. *One minute mathematics (subtraction)*. Pretoria: Human Science Research Council.
- Hynes-Dusel, JM. 2002. Teaching strategies for early childhood movement programs. *Teaching Elementary Physical Education*, 13(1):18-20.
- Infant Reflexes. Available at: <http://facweb.furman.edu/> Accessed: 14/06/2007.
- Jensen, E. 2000a. *Learning with the body in mind*. San Diego, CA: The Brain Store.
- Jensen, E. 2000b. Moving with the brain in mind. *Educational Leadership*, November Issue: 34-37
- Karp GG & DePauw, A. 1989. Neurodevelopment bases of human movement. *The Physical Educator*, 46:77-85.
- Keogh, J & Sugden, D. 1985. *Motor skill development*. New York: MacMillan Publishing Company.
- Kephart, NC. 1975. *The slow learner in the classroom*. Columbus, Ohio: Merrill.
- Kokot, SJ. 2003. A neurodevelopmental approach to learning disabilities. In D. Montgomery (Ed). *Gifted and talented children with special educational needs: double exceptionality (11-24)*. London: David Fulton.
- Kokot, SJ. 2006. Movement and learning. Manual 1. Integrated Learning Therapy Training. Unpublished manual.
- Kranowitz, CS. 1998. *The out-of-sync child*. New York: The Berkeley Publishing Group.
- Kranowitz, CS. 2005. *The out-of-sync child. Recognising and coping with sensory processing disorder*. New York: Skylight Press Books.
- Kuther, T. 2000. Your baby's amazing reflexes. Available at: http://www.suite101.com/article.cfm/development_psychology/46602. Accessed: 20/03/2009.
- Landsberg, E, Krüger, D & Nel, N. 2005. *Addressing barriers to learning. A South African perspective*. Pretoria: Van Schaik Publishers.
- Leppo, ML, Davis, D & Crim, B. 2000. The basic of exercising the mind and body. *Childhood Education*, 76 (3); 142-147.

- Levine, M & Clutch, B. 2009. The mind that's mine. Available at:
<http://www.allkindsofminds.org/excerpt.aspx?productid=11&mode=print>. Accessed 16/03/2009.
- Liddle, TL & Yorke, L. 2004. *Why motor skills matter*. New York: Contemporary Books.
- Louw, G. 2009. Overview of the development and functions of the brain. Unpublished proceedings. 2nd Paediatric Neuropsychology Symposium, held at Pretoria, 19th – 21 October 2009.
- Macnair, P. 2005. *The Kingfisher book of the human body*. London: Kingfisher Publications.
- Marczyk, G, DeMatteo, D & Festinger, D. 2005. *Essentials of research design and methodology*. New Jersey: Wiley & Sons, Inc.
- McCall, RM & Craft, DH. 2000. *Moving with a purpose. Developing programs for preschoolers of all abilities*. Champaign, Illinois: Human Kinetics.
- McMillan, JH & Schumacher S. 2001. *Research in education. A conceptual introduction. 5th Edition*. New York: Longman.
- Movement and Learning. 2009. Available at: <http://movementandlearning.com.au> Accessed: 14/06/2007.
- Mulder, JC. 1993. *Statistical techniques in education*. Pretoria: HAUM Tertiary Publishers.
- National Network for Childcare. 2002. Ages and stages: Newborn to 1 year. Available at:
<http://www.nncc.org/Child.Deve/ages.new.one> Accessed: 6/6/2002.
- National Scientific Council on the Developing Child. 2007. *The timing and quality of early experiences combine to shape brain structure*. Working Paper 5. Available at: <http://www.developingchild.net>
 Accessed: 18/02/2009.
- Nel, JAP. 1999. Child kinetics. Motor development, learning, control and rehabilitation. Unpublished document. University of Western Cape, Cape Town.
- Neuroscience for Kids – Brain development. Available at:
<http://faculaty.washington.edu/chudler/dev.html> Accessed: 21/08/2008.
- Nel, JAP. 2002. Televisie en rekenaar verantwoordelik vir skryf- en leesprobleme by leerders. *Die Unie. Kwartalblad van die Suid-Afrikaanse Onderwysersunie*, 99 (2):3-4.

- O'Dell, NE & Cook, PA. 1997. *Stopping hyperactivity. A new solution.* New York: Avery Publishing Group, Inc.
- Olds, AR. 1994. From cartwheels to caterpillars: Children's need to move indoors and out. *Child Care Information Exchange*, 867:32-36.
- Papalia, D, Olds, SW. & Feldman, RD. 2004. *A child's world. Infancy through adolescence.* 9th edition. New York: McGraw Hill.
- Parker, S. 2007. *The human body book.* London: Dorling Kindersley Limited.
- Pheloung, B & King, J. 1992. *Overcoming learning difficulties.* Brisbane, Australia: Transworld Publishers.
- Pheloung, B. 1997. *Help your class to learn. Effective perceptual movement programs for your classroom.* Sydney: Griffiths Press.
- Pheloung, B. 2003. *Help your child to learn.* Sydney: Iceform.
- Pheloung, B. 2006. School Floors. *Effective perceptual movement programs for your classroom.* Sydney: Iceform.
- Pica, R. 2004. *Experiences in movement. Birth to age 8.* Canada: Thompson, Delmar.
- Piek, JP, Dawson, L, Smith LM, & Gasson, N. 2008. The role of early fine and gross motor development on later motor and cognitive ability. *Human Movement Science*, 27(5): 668-681.
- Ratey, JJ & Hagerman, E. 2009. *Spark! How exercise will improve the performance of your brain.* London: Quercus.
- Reber, AS & Reber, ES. 2001. *The Penguin dictionary of psychology.* London: Penguin Books.
- Reflexes. The Institute for Neuro-Physiological Psychic. Available at: <http://www.inpp.org.uk/reflexes>. Accessed: 12/03/2006.
- Rose, S. 2005. *The 21st century brain. Explaining, mending and manipulating the mind.* London: Jonathan Cape.
- Salkind, NJ. 2003. *Exploring research.* New Jersey: Prentice Hall.
- Seaman, JA, DePauw, KP, Morton, KB & Omoto, K. 2003. *Making connections. From theory to practice in adapted physical education.* Arizona: Holcomb Hathaway Publishers.

Sensory Processing Dysfunction – Vestibular Activation. February 1, 2009. Available at: <http://www.autism-community.com/senory-processing-dysfunction-activation>. Accessed: 24/02/2007.

Singh, R. 1993. *Sportstart: Developing your kids' skills at home*. Fyshwick, ACT: Australian Sports Commission.

Summerford, C. 2001. What is the Impact of exercise on brain function for academic learning. *Teaching Elementary Physical Education*, 12 (3):6-8.

The central nervous system. Available at: <http://drstandley.com> Accessed: 21/04/2009.

The nervous system. Available at: <http://estrellemountatin.edu/faculty/farbee> Accessed 13/03/2009.

University of South Africa. 2005. UCT Spelling assessment. In Study guide OSV453-5: Diagnosing children with learning difficulties. Unpublished study guide. Department Educational Studies, University of South Africa.

Van der Westhuizen, B. 2007. An ecosystemic approach to addressing attentional difficulties and heightened motor activity. Unpublished DEd in Psychology of Education. University of South Africa, Pretoria.

Vo-Vu, J. 1999. Critical issue: Promoting children's readiness to learn. Available at: <http://www.ncrel.org/sdrs/areas/issues.students/earlycld/ea/700.html> Accessed: 20/11/2008.

Walker, P. 1995. *Baby massage. A practical guide for massage and movement for babies and infants*. New York: St Martin's Griffin.

Walker, R. 2003. *Encyclopaedia of the human body*. London: Dorling Kindersley Limited.

Welman, JC & Kruger, SJ. 2004. *Research methodology*. Cape Town: Oxford University Press.

Werner, PS, Timms, S & Almond, L. 1996. Health stops: Practical ideas for health-related exercise in preschool and primary classrooms. *Young Children*, 51 (6):48-53.

Williamson, G & Anzalone, ME. 2001. *Sensory integration and self-regulation in infants and toddlers: Helping very young children interact with their environment*. Washington: Zero to Three.

Winston, R. 2004. *Human. The definitive visual guide*. London: Dorling Kindersley.

ADDENDUM A: Physical development milestones 6 weeks – 9 months

Age	Average milestone	He might be able to	Should be able to
Six weeks	<ul style="list-style-type: none"> • Holds head up briefly • Turns briefly to sources of light and sound • Communicates by crying 	<ul style="list-style-type: none"> • Follow objects with his eyes • Smile voluntarily • Lift and turn his head when lying on his back 	<ul style="list-style-type: none"> • Startled reaction to sudden movement or loud sound • Suck strongly
Three weeks	<ul style="list-style-type: none"> • Raises chest on elbows when lying on his tummy • Holds head up when held upright • Smile and laughs spontaneously • Turns towards familiar voices 	<ul style="list-style-type: none"> • Sit up with some support • Coo and gurgle • Squeal when happy • Focus on small objects • Reach out to objects 	<ul style="list-style-type: none"> • Smile • Respond to movement and sound
Four months	<ul style="list-style-type: none"> • Pulls his upper body up when his hands are held • Hold his head up when held upright • Grasps a rattle 	<ul style="list-style-type: none"> • Lifts his chest with straightened arms when placed on tummy 	<ul style="list-style-type: none"> • Coo and gurgle • Respond to mother and father's voice • Follow movement with his eyes
Six months	<ul style="list-style-type: none"> • Reach out and grasp objects • Puts objects to his mouths • Bounce when held in a standing position • Rolls from stomach to back 	<ul style="list-style-type: none"> • Sit unaided • Imitate the sound of other voices • Make double-syllable sounds like 'goo-goo' • Look for dropped toys 	<ul style="list-style-type: none"> • Roll over and back again • Use both hands • Have control over limb and hand movement • Babble and coo
Nine months	<ul style="list-style-type: none"> • Hold a toys in each hand • Claps hands • Eats finger foods • Drinks from a cup • Shouts or gestures for attention • Makes singing sounds • Waves goodbye 	<ul style="list-style-type: none"> • Pick up a small object between thumb and forefinger • Crawl or inch his way across the floor • Pull himself to a standing position • Stand unaided for a few seconds • Say 'mama' or 'dada' • Respond to single instructions 	<ul style="list-style-type: none"> • Hold his head up steadily • Sit unaided • Grasp and hold objects • Babble and coos

Source: National Network for Childcare (2002:1-5) and De Jager (2009:99-116)

ADDENDUM B: Physical development milestones 12 – 24 months

Age	Average Milestone	He might be able to	He should be able to
Twelve months	<ul style="list-style-type: none"> • Walks while his hands are held • Walks while holding on to furniture • Stands unsupported for a few seconds • Pulls self to a standing position • Says at least five words • Understands simple instructions • Responds to own name • Points to objects 	<ul style="list-style-type: none"> • Take a few steps unaided • Roll and catch a large ball 	<ul style="list-style-type: none"> • Say 'mama' or 'dada' • Crawl or creep with legs extended • Put food in his mouth
Fifteen months	<ul style="list-style-type: none"> • Can walk unaided • Has a vocabulary of over 10 words • Attempts to feed himself with a spoon • Can stack at least two blocks • 	<ul style="list-style-type: none"> • String together two words • Climb up stairs 	<ul style="list-style-type: none"> • Pull himself to a standing position • Stand unaided • Say at least five words
18 months	<ul style="list-style-type: none"> • Walks unaided • Can walk backwards • Throws a ball without falling • Picks up toys from the floor without falling • Makes two-word sentences • Understand most instructions 	<ul style="list-style-type: none"> • Successfully feed himself with a spoon • Turn the pages of a book • Identify pictures in a book 	<ul style="list-style-type: none"> • Make an effort to walk
24 months	<ul style="list-style-type: none"> • Runs • Kicks a ball • Climbs up and down stairs • Builds a tower of six blocks • Can draw horizontal and vertical lines • Says short phrases • Refers to himself by name 	<ul style="list-style-type: none"> • Undress himself • Walk on tip-toe • Repeat nursery rhymes and songs • Jump on both feet 	<ul style="list-style-type: none"> • Walk unaided • Use at least two-word sentences • Understand simple commands

Source: National Network for Childcare (2002:1-5) and De Jager (2009:99-116)

ADDENDUM C: Gross motor development chart – age range 2 years 6 months – 6 years (Walking to jumping)

	2 years 6 months	3 years	4 years	5 years	6 years
Walking	Walks up and down stairs two feet to a step with hand on wall	Walks alone upstairs	Walks or turns alone up and down stairs, one foot to a step. Walks easily on narrow line	Can heel/toe walk. Walks up and down stairs carrying objects in both hands	Walks backwards toe/heel
Running	Runs well straight forward	While running can turn around obstacles and corners	While running can skilfully navigate and turn sharp corners	Can, stop start, turn while running	
Walking on toes	Walks on tiptoe after demonstration	Can stand and walk on tiptoe	Can now run on tiptoe	Runs lightly on toes	Runs around obstacle course
Jumping	Jumps with both feet in place	Jumps from the bottom of step of a flight of steps, two get together	Can jump from a low height with two feet together	From standing, jumps with two feet together	Jumps over a rope 25 cm above the ground
Standing on one foot	Tries to stand on one foot	Maintains standing balance heels together, stand momentarily on preferred foot	Stands on one foot two to seven seconds	Can stand on either foot eight to twelve seconds	

Source: Singh (1993:21)

**ADDENDUM D: Gross motor development chart – age range 2 years 6 months to 6 years
(Hopping to bouncing)**

	2 years 6 months	3 year	4 years	5 years	6 years
Hopping	Generally not present	At 3 years 6 months can hop one to three times on preferred foot	Hops on preferred foot four to six times	Can hop forward about ten hops on preferred foot. One leg is more dominant	Able to hop on alternate legs 3 metres
Galloping	Generally not present (basic)but inefficient gallop at about 4 years		Some children have a basic galloping pattern on preferred foot.	Most children can gallop in a co-ordinated way.	Can gallop, leading with right leg or left leg.
Skipping	Generally not present (one footed skip at about four years old)		Approximately 15 % can skip at this stage.	Most children about to achieve this on alternate feet .	85 % can skip.
Throwing	Ball thrown with forearm extension only	Can throw a ball overhead.	Can roll a ball.	Immature underarm pattern if small ball used. Can toss one to five bean bags into a container.	Throws and can catch bounced tennis ball with both hands.
Catching	Responds to 'Aerial' ball with delayed arm movements .	Catches large ball tossed gently and accurately onto or between straight arms.	Can catch bean bag. Can catch large ball with elbows bent.	Thrower must be accurate for a successful catch. Catches with clapping then scooping action using arms to chest.	Catches with hands. Starting to catch tennis ball.
Bouncing	Generally not present. Can roll a ball to an adult.	Can bounce a large ball fairly competently.	Bounces/ pats large ball two or more time with both hands.	Small bounce and catch small ball but not always successful.	Single bounce and catch mastered. Attempts more than one bounce but often too forcefully and the bounce is irregular. Dominant side only.

Source: Singh (1993:22)

ADDENDUM E: Gross motor development chart – age range 2 years 6 months to 6 years (Kicking to rhythm)

	2 years 6 months	3 years	4 years	5 years	6 years
Kicking	Kicks a large ball.	Kicks a ball strongly.	Walks up and kicks a stationery ball.	Stands on one leg and kicks with the other becoming stronger. Reluctant to kick moving ball.	Kick moving object. Moves to objects an attempts to stop it.
Riding tricycle	Sits on pedal cycle and steers but propels with feet on floor.	Rides tricycle pushing pedals and steers if around corners.	Expert tricycle rider executing sharp U turns.	Rides small bike with training wheels.	Has started to master a small bicycle.
Climbing	Climbs easy playground equipment.	Climbs playground equipment, often using two feet on to a step.	Climbs ladder and trees alternate arm and leg position.	Skilful in climbing, sliding, swinging and digging.	Requires a variety of equipment to encourage exploration in climbing.
Rhythm	Children begin developing their rhythmic abilities during infancy-coping response to soft rhythmical sounds. As they grow, they continue to explore and expand their environment.	Whole body movement to music.	Movements of separate body parts to music. Walking to rhythm.	Move rhythmically to music, marches in time.	Galloping, jumping and running in rhythm to simple tunes.

Source: Singh (1993:23)

ADDENDUM F: Learning area: Life orientation - Assessment standards (RNCS Grades R-9 schools)

Learning Outcome 4: Physical Development and Movement

The learner will be able to demonstrate an understanding of, and participate in, activities that promote movement and physical development.

The learner in the Foundation Phase enters school with many emerging motor control, body awareness and perceptual motor abilities which need further development. The learner's affective and social response are usually egocentric. Through discovery, the learner needs to develop the necessary skills for each of the developmental aspects. Using a variety of new functional movements, the learner develops an awareness of the body and how to move in challenging, exploratory and problem-solving ways.

ASSESSMENT STANDARDS

Teachers need to remember that not all learners will have attended Grade R. Concepts, skills and strategies for Grade R need to be taught and consolidated in Grade 1.

Grade R : Assessment Standards

We know this when the learner:

- Plays running, chasing and dodging games using space safely.
- Explores different ways to locomote, rotate, elevate and balance.

Grade 1: Assessment Standards

We know this when the learner:

- Demonstrates ways of throwing, striking, rolling, bouncing, receiving and moving with a ball or similar equipment.
- Uses a combination of body parts to locomote, rotate, elevate and balance, with or without equipment.

Grade 2 : Assessment Standards

We know this when the learner:

- Participates in a variety of indigenous outdoor games with simple rules, individually and with a partner
- Participates in activities to develop control, co-ordination and balance in the basic actions of locomotion, elevation and rotation, with equipment.

Grade 3: Assessment Standards

We know this when the learner:

- Demonstrates a variety of perceptual motor skills, in pairs and in teams, using simple rules.
- Performs basic movements in sequence and with repetition, with and without equipment.
- Performs expressive movements using different parts of the body.
- Participates in free play activities.
- Responds to a variety of stimuli and expresses a range of different moods and feelings through movement.
- Participates in free play activities using a variety of equipment.
- Performs expressive movements or patterns rhythmically, using various stimuli.
- Participates in structured activities using equipment.
- Explores expressive movements using contrasts of speed, direction, body shape and position.
- Participates in play and describes its effects on the body.

Source: Department of Education (2002a:15, 22-23)

ADDENDUM G: Principal consent form

**The Principal
Xxxxxxxx Primary School**

Dear Mr xxxxxx

Date: 2 February 2009

It is of concern that a large number of learners entering the school setup and currently in the system are not considered learning ready. These days it is widely recognised that 'readiness' is a prerequisite for successful achievement at school. The neurological growth and development, skills development, the reflex systems, and various motor and perceptual concepts are important in the development of the child and learning readiness. Movement plays a vital role in activating many of our mental capacities and helps to integrate and anchor new information and experiences in our neural networks. Numerous studies have seen the significance of movement in the development of learning readiness. All learning takes place in the brain, yet it is the body which acts as the vehicle by which knowledge is acquired. This has led to the need to determine if movement programmes are a means to learning readiness. With this aim in mind I would like to request permission to conduct a research study with the special class in order to answer a few research questions:

- What is the current motor proficiency level of learners with regards to vestibular, proprioception, muscle tone, tactile, visual and auditory functioning?
- Can a specifically designed movement programme improve their motor proficiency as well as their current level of learning readiness?

Prior to the onset of the programme each child will be assessed where information will be gathered regarding their academic ability in 1 minute reading, 1 minute maths (addition and subtraction), and the UCT spelling test. The 7/8 year old group test and the Bender Gestalt II assessment will also be used to determine the child's current functioning as well as motor and perceptual abilities. The programme will run over ten consecutive weeks and for 30 minutes every day. I will be present twice weekly with the implementation of the programme. After the movement programme has been completed a second assessment will be conducted and the results will be analysed and compared with the pre test results.

The research project will be conducted under the supervision of Prof. D. Kruger and with ethical approval of the University Of South Africa (UNISA). The final report of the study will be submitted as a dissertation of limited scope for my Masters degree in Guidance and Counselling.

I hereby confirm that I will adhere to the following ethical conditions:

- 1) The child's name will not appear at any point of information collection, or in the final report of the data.
- 2) All information will be dealt with confidentially and written consent will be requested from the parents.
- 3) The child's participation in this research is voluntary. He/she has the right to withdraw at any point of the study, for any reason, and without any prejudice.
- 4) The school's name will not be mentioned in the research study or in any publication which might be generated from this study.

You are encouraged to ask any questions at any time regarding the nature and the methodology of the study. Your suggestions and concerns are important and please feel free to discuss these with me at any time.

Thank you for giving me the opportunity to conduct this research study at xxxxxx Primary

Researcher obtaining consent:

Consent granted:

Dr Soezin Krog

Mr xxxxxxx
Principal: xxxxxxxPrimary

Date:

Date:

ADDENDUM H: Parent consent form

Dear Parents

It is of concern that a large number of learners entering the school setup and currently in the system are not considered learning ready. These days it is widely recognised that 'readiness' is a prerequisite for successful achievement at school. The neurological growth and development, skills development, the reflex systems, and various motor and perceptual concepts are important in the development of the child and learning readiness. Movement plays a vital role in activating many of our mental capacities and helps to integrate and anchor new information and experiences in our neural networks. Numerous studies have seen the significance of movement in the development of learning readiness. All learning takes place in the brain, yet it is the body which acts as the vehicle by which knowledge is acquired.

Permission has been granted by Mr xxxxxxxxxxxx the Principal of xxxxxxxxxxxx to conduct a research study in the school. The aim of the study is to determine if: *Movement programmes are a means to learning readiness*. This study forms part of the completion of a Masters degree in Guidance and Counselling.

Your permission is requested for your child to partake in this study which will take place under the supervision of the principal and the class teacher. Pre-tesing will be conducted to determine each child's level of functioning in mathematics, reading, spelling and general functioning. The learners will also be tested with regards to integrated reflexes, evaluation of body concept, body schema, balance, midline crossing, vestibular functioning, muscle tone, proprioception, the visual system, laterality, directionality, interhemispheric integration, auditory functioning and tactility.

A movement programme will be designed to include the above mentioned aspects. This programme will be followed for 10 weeks for five days a week. No interruption of the formal teaching programme will take place. Learners will be reassessed after the completion of the movement programme. Post testing will be conducted in order to determine if there is any improvement regarding the various aspects which were assessed. The following ethical measures are considered in the study:

- Confidentiality is of utmost importance.
- Your child's name and the name of the school will not be mentioned at any stages of the capturing or processing of the data.
- Your child has the right to withdraw at any point of the study, for any reason, and without any prejudice.
- This study forms part of a Masters degree and the results might possibly be included in a publication generated from this study.
- The study is undertaken under the supervision of Prof D Kruger and with ethical approval of the University of South Africa.

You are encouraged to ask any questions at any time regarding the nature and the methodology of the study. Your suggestions and concerns are important and please feel free to discuss these with me at any time.

Thank you for giving me the opportunity to incorporate your childin this research study at xxxxxx Primary

Your sincerely

.....
DR SOEZIN KROG

.....
PARENT

.....
DATE

ADDENDUM I: Educator consent form

Dear Mrs A K

It is of concern that a large number of learners entering the school setup and currently in the system are not considered learning ready. These days it is widely recognised that 'readiness' is a prerequisite for successful achievement at school. The neurological growth and development, skills development, the reflex systems, and various motor and perceptual concepts are important in the development of the child and learning readiness. Movement plays a vital role in activating many of our mental capacities and helps to integrate and anchor new information and experiences in our neural networks. Numerous studies have seen the significance of movement in the development of learning readiness. All learning takes place in the brain, yet it is the body which acts as the vehicle by which knowledge is acquired.

Permission has been granted by Mr xxxxxxxxxxxx the Principal of your school to conduct a research study in the school. The aim of the study is to determine if: *Movement programmes are a means to learning readiness*. This study forms part of the completion of a Masters degree in Guidance and Counselling.

Permission is requested for you and your class to partake in this study which will take place under your and my supervision. Pre-testing will be conducted to determine each child's level of functioning in mathematics, reading, spelling and general functioning. The learners will also be tested with regards to integrated reflexes, evaluation of body concept, body schema, balance, midline crossing, vestibular functioning, muscle tone, proprioception, the visual system, laterality, directionality, interhemispheric integration, auditory functioning and tactility. A movement programme will be designed to include the above mentioned aspects. This programme will be followed for 10 weeks for five days a week. No interruption of the formal teaching programme will take place. Learners will be reassessed after the completion of the movement programme. Post testing will be conducted in order to determine if there is any improvement regarding the various aspects which were assessed. The following ethical measures are considered in the study:

- Confidentiality is of utmost importance.
- The child's name and the name of the school will not be mentioned at any stages of the capturing or processing of the data.
- The child has the right to withdraw at any point of the study, for any reason, and without any prejudice.
- This study forms part of a Masters degree and the results might possibly be included in a publication generated from this study.
- The study is undertaken under the supervision of Prof D Kruger and with ethical approval of the University of South Africa.

With regards to training, you will be provided with a detailed programme and demonstration of the movement programme. I will be assisting you twice a week during the presentation of the movement programme.

You are encouraged to ask any questions at any time regarding the nature and the methodology of the study. Your suggestions and concerns are important and please feel free to discuss these with me at any time.

Thank you for giving me the opportunity to incorporate you and your class, in this research study at xxxxxx Primary

Your sincerely

.....
DR SOEZIN KROG

.....
EDUCATOR

.....
DATE

ADDENDUM J: Assessment of movement proficiencies

					Score	
					Total	
VESTIBULAR SYSTEM			COMMENTS			
1	Manns test : Standing heel/toe Eyes open - 10 seconds	Unbalanced Falls over quickly	0	1		
2	Eyes closed - 10 seconds	Unbalanced Falls over quickly	0	1		
One leg test						
3	Preferred foot - Eyes closed 10 sec	Right / Left	0	1		
4	Non preferred leg – Eyes close 10 sec	Right/Left	0	1		
Postrotary-nystagmus						
5	Ocular muscle control (turn head 60° to left & right)		0	1		
TONIC MUSCLE CONTROL						
1	Lie on back hold legs 20 to 30 degrees off the ground	Phasic muscle tone: Bobs up and down	0	1		
PROPRIOCEPTIVE SYSTEM			Laterality and directionality			
1	Angel in the Snow Test 1. Both arms and legs	Coordinated Move without hesitation Without looking Without touching Without banging on floor	0	1		
2	2. Both arms		0	1		
3	3. Both legs		0	1		
4	4. Right arm		0	1		
5	5. Left arm		0	1		
6	6. Right leg		0	1		
7	7. Left leg		0	1		
8	8. Right arm and right leg		0	1		
9	9. Left arms and left leg		0	1		
10	10. Right arm and left leg		0	1		
11	11. Left arm and right leg		0	1		
Rhomberg test						
12	Standing feet together Arms relaxed at side Close eyes	<i>Loss of balance Weaving back and forth Lifting or moving feet apart Lifting one or both arms</i>	0	1		
Reciprocal limitations						
13	Imitate the evaluators movements Turn one palm of hand upwards other down Lift one arm and lower the other arms	<i>Can the child do the skill Maintain the same rhythm Separate two sides of the body Coordinate the movements</i>	0	1		
Index Finger-Nose Test						
14	Preferred hand Arms raised to shoulder level & extended straight out at side Touches index finger on preferred hand on nose Returns to starting position	<i>Brings hand to nose Bends head to hand Misses or hit nose Lowers the arms</i>	0	1		
15	Lift non preferred hand Touch index finger on non preferred hand on nose Return to starting position.		0	1		
Shoulder-Level Arm Raise Test						
16	Raise preferred arm to shoulder level X 4 close eyes	Change level of arms Poor proprioception	0	1		
17	Repeat on the non-preferred arm to shoulder level X 4 close eyes	Change level of arms Poor proprioception	0	1		

TACTILE SYSTEM		COMMENTS		
1	left forearm	Can't feel touch	0	1
2	Left face		0	1
3	Right face		0	1
4	Right forearm		0	1
5	Right knee		0	1
6	Right hand		0	1
7	Left knee		0	1
8	Left hand		0	1
9	Object-Identification Test Blind fold child & he/she must identify objects	Can't identify objects	0	1
10	Tracing number test on back	Can't identify objects	0	1
VISUAL SYSTEM				
1	Fixation on object 10 sec	Head normal position Change from one eye to another Sitting still not wriggling around	0	1
2	Divergence (any one)			
	Smooth		0	1
	Jerky		0	1
	Watery		0	1
	Doesn't focus on pen eyes move away		0	1
3	Binocular fusion			
	One pencil How many does the child see		0	1
4	Visual tracking			
	15x horizontal	Moves head Eyes move in S Blink in middle	0	1
	15x vertical	Moves head Eyes moves in S Blink in middle	0	1

REFLEXES		Scoring	Total	
1	9 ATNR Arms outstretched turn head	0 = no response 1 = slight arm movement/same direction as head 2 = arms move with head 45 degrees & drop 3 = arms move as much as 60 degrees & drop 4 = 90 degree rotation. Loss of balance as head turns Arms drop together separately	0 1 2 3 4	
2	9 STNR On all fours, head up and down	0 = No response 1 = Tremor in one /both arms/slight hip movement 2 = elbow movement/hip movement /arching back 3 = definite arm bending as result of head flexion 4 = bends arms to floor/ moves bottom back onto ankles "cat position"	0 1 2 3 4	
3	9 TLR Arms next to side look up & down	0 = no response 1 = slight alteration of balance as result of head 2 = impairment balance during test/ alteration muscle tone wobbly 3 = near loss balance/alteration muscle tone/ disorientation as result of test procedure/unsteady	0 1 2 3 4	
4	9 HRR (Sitting tip side to side) Forwards and backwards	0 = Head corrects to the vertical midline position throughout the testing 1 = Head slips slightly from the vertical 2 = Head follow direction of the tilt in line with body 3 = Head slips below the line of the body 4 = Head drops in the direction of the tilt – no righting apparent	0 1 2 3 4	
5	9 Moro reflex Standing hold child and drop back	0 = subject falls back with no alteration of arm position 1 = reddening of the skin or slight but quickly controlled 2 = inability to drop back, movement of the arms and hands outwards, dislike of procedure 3 = movement of arms accompanied by 'freezing' momentarily in this positions, grasp of breath, reddening of the skin or pallor 4 = complete abduction of the arms and hands outward accompanied by gasp, freeze and possibly cry,	0 1 2 3 4	
Dominance				
1	Hand dominance	Right 1 / Left 2	1	2
Body Awareness				
1	Head		0	1
2	Nose		0	1
3	Elbows		0	1
4	Ankles		0	1
5	Eyes		0	1
6	Mouth		0	1
7	Feet		0	1
8	Ears		0	1
9	Shoulders		0	1
10	Hips		0	1
11	Knees		0	1

ADDENDUM K: Consolidated scoring sheet

SCORING SHEET						Office use only
Number:						1 – 2
Age:			.			3-7
Gender Male 1 /Female 2						8
IQ – 7/8 year old group test						
(subtest 1) Comparison						9-10
(subtest 2) Mazes						11-12
(subtest 3) Verbal comprehension						13-14
(subtest 4) Figure classification						15-16
(subtest 5) Number comprehension						17-18
(subtest 6) Pattern completion						19-20
Total IQ						21-23
Percentile						24-25
Bender Gestalt II (Visual Motor Gestalt Test)						
Motor						26-27
Percentile range						28-29
Perception						30-31
Percentile range						32-33
Standard score (copy)						34-36
Percentile rank (copy)			.			37-41
T-score (copy)						42-43
Standard score (recall)						44-46
Percentile (recall)			.			47-51
T-Score (recall)						52-53
1 Minute tests						
Maths: Addition 1 Minute			.			54-58
Subtraction 1 Minute			.			59-63
UCT Spelling:			.			64-68
Reading: 1 Minute			.			69-73
Movement assessment:						
Vestibular						74
Muscle tone						75
Proprioception						76-77
Tactile						78-79
Visual						80
Reflexes						81-82
Auditory						83
(Right 1 /left 2) Dominance: Hand						84
Body Awareness						85-86

SCORING SHEET						Office use only
Number:						88-88
Age:			.			89-93
Gender Male 1 /Female 2						94
IQ – 7/8 year old group test						
(subtest 1)Comparison						95-96
(subtest 2) Mazes						97-98
(subtest 3) Verbal comprehension						99-100
(subtest 4)Figure classification						101-102
(subtest 5) Number comprehension						103-104
(subtest 6)Pattern completion						105-106
Total IQ						107-109
Percentile						110-111
Bender Gestalt II (Visual Motor Gestalt Test)						
Motor						112-113
Percentile range						114-115
Perception						116-117
Percentile range						118-119
Standard score (copy)						120-122
Percentile rank (copy)			.			123-127
T-score (copy)						128-129
Standard score (recall)						130-132
Percentile (recall)			.			133-137
T-Score (recall)						138-139
1 Minute tests						
Maths: Addition 1 Minute			.			140-144
Subtraction 1 Minute			.			145-149
UCT Spelling:			.			150-154
Reading: 1 Minute			.			155-159
Movement assessment:						
Vestibular						160
Muscle tone						161
Proprioception						162-163
Tactile						164-165
Visual						166
Reflexes						167-168
Auditory						169
(Right 1 /left 2) Dominance: Hand						170
Body Awareness						171-172