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BIRTH FACTORS AND VISUAL MOTOR INTEGRATION IN CHILDREN AGED FIVE TO SEVEN YEARS WITH AND WITHOUT LEARNING DISORDERS

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

Johannesburg, 2017

DECLARATION

I, Lauren Joy Ferraris, declare that this research report is my own unaided work. It is being submitted for the degree of Master of Science in Occupational Therapy at the University of Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.



_____

Lauren Ferraris

19th day of June in the year 2017

DEDICATION

This research is dedicated to my three children, Caitlin, Michaela and Christopher and my husband Steven Ferraris. May they continue to inspire me to be a good and gracious role model as a wife, mother and as an occupational therapist.

ABSTRACT

This research explored the birth factors and visual motor integration in children using a quantitative descriptive cross sectional design. Thirty six children aged five, six and seven years old in the Northern Suburbs of Johannesburg, South Africa, were tested using the Beery-Buktenica Developmental Test of Visual Motor Integration and birth factors were determined through a parental questionnaire. The sample consisted of children from mainstream schools and schools for children with special needs. Results showed highly significant statistical differences between the two school groups in the Beery subtests; however, no statistical differences were recorded for scores between the modes of delivery, except for the Beery visual motor integration subtest of visual perception between the normal vaginal delivery and the emergency caesarean section groups. Other factors of significance were that children with special needs were more often under the care of a paediatrician, taking more medication, had more frequent hospitalisations and attended more therapy. Differences were also found in gestational age and birth weight between children born via different modes of delivery. Birth factors and medical history should be noted as possible indicators for further assessment of learning disorders.

KEYWORDS: Learning Difficulties, Perinatal, Birth Factors, Occupational Therapy, Visual Motor Integration

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DEFINITIONS

Learning Disorder: According to the DSMV, a Learning Disorder occurs when a person achieves scores which are significantly lower than their age group for both intelligence tests and academic tasks, including reading, mathematics or written expression. This impacts their scholastic achievement [1]. In this research report the term learning disability from the reviewed literature will be replaced with learning disorder/ learning difficulty as termed in the DSMV.

Occupational Therapy: Defined by the American Association of Occupational Therapists as “the art and science of directing man’s participation in selected activity to restore, reinforce and enhance performance, facilitate learning for those skills and functions essential for adaption and productivity, to diminish or correct pathology and to promote and maintain health.” (p667) [2].

Visual Motor Integration: The ability to combine and co-ordinate visual perception and fine motor skills [3].

Visual perception: Term used for the conscious analysis and interpretation of visual stimuli [3].

Fine Motor Co-ordination: Refers to the dexterity of the hand and fingers in unilateral and bilateral tasks. Eye-hand co-ordination refers to how well an individual’s hands and eyes function together to produce co-ordinated movement [4].

Activities of Daily Living: The broad term which incorporates two areas of functioning namely personal/basic activities of daily living and instrumental activities of daily living. Personal activities of daily living include those activities to care for one’s own body. Instrumental activities of daily living are those more advanced activities in all performance areas that allow an individual to function independently in a community. These require the use of executive functions, social skills and other cognitive skills for more complex interaction with the environment [5].

Perinatal Birth Period: The period from 5 months before and 28 days after birth. Both in-utero and external risk factors impact the health of the infant [6].

Normal Vaginal Delivery: Defined by the World Health Organization as physiological labour, which is spontaneous in onset at between 37-42 weeks and low risk, followed by a vaginal birth where there is little intervention due to low risk. After which the mother and infant are in good condition [7].

Elective Caesarean Section: The definition of an elective caesarean section for the purpose of this study will be considered as gestation from 37-39 weeks as defined in Mackay, D., Kerr-Wilson C. Smith G., Pell, J.'s study (2010) [8].

Emergency Caesarean Section: Indicated for the following medical conditions: namely placenta previa, HIV infection, contracted pelvis, breech presentation or a previous caesarean section [9].

ABBREVIATIONS

ADD:	Attention deficit disorder
ADL:	Activities of daily living
DSMV:	Diagnostic and Statistical Manual of Mental Disorders, 5th Edition
DTVP-2:	Developmental Test of Visual Perception, second edition
ELCS:	Elective caesarean section
EMCS:	Emergency caesarean section
HIV:	Human immunodeficiency virus
IQ:	Intelligence Quotient
LBW:	Low birth weight
MAP:	Millers Assessment for Preschoolers
MSS:	Mainstream schools
MVPT-3:	Motor-free Visual Perceptual Test, 3rd edition
NVD:	Normal vaginal delivery
SCSN:	Schools with children with special needs
TVMS:	Test of Visual-Motor Skills
TVPS-R:	Test of Visual Perceptual Skills, Revised
UK:	United Kingdom
USA:	United States of America
VLBW:	Very low birth weight
VMI:	Visual Motor Integration
WISC-R:	Wechsler Intelligence Scale for Children, Revised
WISCV:	Wechsler Intelligence Scale for Children, 5th Edition

CHAPTER ONE – INTRODUCTION

1.1 Introduction

Learning disorders affecting reading, writing and arithmetic, which are important tools for daily living, has a prevalence of 4-7% for school-aged children worldwide [10]. Scholars with learning disorders comprise approximately 50% of learners with special educational needs in the United States of America (USA) [10]. There are no statistics available for South Africa (SA).

The USA National Centre for Educational Statistics recorded a rise in learning disorders between 1990 and 2007 highlighting a need for further research into the aetiology and intervention of these conditions [10, 11]. This has increased the number of children needing referral to schools for children with special needs (SCSN). Children identified with special educational needs require the support of specialist teachers and therapists which can only be provided in specialised schools that cater for such children. Mainstream schools (MSS), however, provide this support to a limited degree [12].

Occupational therapists are amongst those involved in the research of non-verbal learning difficulties as they are part of the team of health care professionals involved in the initial assessment and remediation of young children with non-verbal learning difficulties.

An increasing number of children with non-verbal learning difficulties are being referred for occupational therapy and the on-going debate regarding aetiology of learning disorders is of concern to this profession. It is important that the aetiological factors related to learning disorders are known so that children exposed and at risk can be identified early and intervention provided, before they fail to achieve academically. Research has proposed that early diagnosis and treatment of children, particularly children born at risk, can reduce the number of children requiring special education or compensatory education programs by up to 70% [13].

The aetiology of learning disorders has been linked to prenatal, perinatal and postnatal factors [10]. Low birth weight and preterm birth are examples of factors that research highlights as a cause of learning disorders [14] .

The perinatal factors are of particular interest in South Africa, as there is variability between the numbers of caesarean section deliveries in the different socio-economic sectors during childbirth. A study in 2007 indicates that the healthcare of women during and after childbirth in provincial hospitals was not always adequate [15]. A 40 - 60% rate of home delivery has been reported in some less developed areas of South Africa, like the Eastern Cape, with care being offered by a traditional birth attendant, frequently a woman who has no qualification, but rather has learnt through experience [16].

A study has reported that 88% of births in South African public hospitals were vaginal deliveries, with no additional statistical information as to whether these were assisted deliveries. The caesarean section rate ranged from 19%-28% at public hospitals [17].

The birth of infants in the private hospitals in South Africa, attended mostly by 20% of the population that has access to a medical aid fund, has a caesarean section rate of 70%, approximately 50% of which are elective caesarean section (ELCS). This is five times more than the WHO recommended rate, and is nearly three times more than that in the public sector hospitals [17, 18]. The pregnancy and birth process in the private sector is supervised over 80% of the time by an obstetrician and/or gynaecologist whereas in the public sector the patient may only be under the care of a midwife during her pregnancy and birth [19].

The delivery of an infant via any mode has been shown to impact the health of the mother and the infant. The birthing factors influencing the health of the infant most commonly linked to learning difficulties are genetic influences, low birth weight and prematurity [20]. Other perinatal complications including prolonged labour, breech delivery, use of forceps, caesarean section, assisted delivery and jaundice have also been identified in children with coordination and sensory processing problems, which are related to learning disorders.

These are implicated as possible aetiological factors with this group [20]. It is not known if the modes of delivery woman have in these hospitals are associated with later learning difficulties.

1.2 **Statement of the problem**

There is an increase in the number of referrals for children with non-verbal learning difficulties and in the severity of these learning difficulties [21]. Research into the causes of this increase in the number of children presenting with learning difficulties will aid in improving the early identification of non-verbal learning difficulties that subsequently will improve the prognosis, and will lessen the impact of these non-verbal learning difficulties on the social, emotional and scholastic performance throughout schooling [21, 22].

Learning disorders have their origins in genetic and environmental risk factors [23]. The aetiology of learning disorders has been linked to prenatal, perinatal and postnatal factors [10]. Infants born preterm or underweight have been found to be at greater risk for learning disorders [14].

With the high incidence of caesarean sections in the private health sector of South Africa [18] and a poor understanding of the effect of different modes of delivery on learning disorders in relation to the impact of gestational age, there is a great need for more information to ensure that mothers are able to make informed decisions regarding their health and that of their babies.

1.3 Purpose of the study

The results of the research will provide information to health care professionals and teachers as to the birth factors that are different between children with and without learning difficulties.

Moreover, by establishing if certain birth factors are present in children with learning difficulties in a certain population, occupational therapists will be able to screen and identify children with these birth factors earlier. Education of other health professionals and parents can also result in earlier referral of children.

Occupational therapists, as part of the team of health care professionals, can then aid in the treatment of dysfunctional skills and the possible prevention of non-verbal learning difficulties [24].

1.4 Research Question

Is there a difference in antenatal and perinatal birth factors and Beery visual motor integration (VMI) scores between:

- Children who attend mainstream schools and schools for children with special needs?
- Children who are born via different modes of delivery?

1.5 Aim

To describe the difference in antenatal and perinatal birth factors and Beery VMI scores according to the schools the children attend (whether they have learning disorders or not) and their mode of delivery at birth.

1.6 Objectives

- To describe the differences in mode of delivery, pregnancy complications, gestational age, birth weight, APGAR scores, medical history, attendance of therapy and Beery VMI scores of children aged five to seven years in MSS and SCSN.
- To describe the differences in pregnancy complications, gestational age, birth weight, APGAR scores, medical history, attendance of therapy and Beery VMI scores of children aged five to seven years who were born via different modes of delivery.

1.7 Justification for the study

In recent years occupational therapists have experienced increasing caseloads of children referred for non-verbal learning difficulties. There has been debate as to why there is an increase in the case-loads of occupational therapists treating non-verbal learning difficulties.

One such debate, stimulated by the increasing rate of caesarean sections, is whether there is a link between caesarean sections and later learning difficulties requiring the referral to an occupational therapist. This debate is based on the theory that when a baby passes through the birthing canal during a vaginal birth, the proprioception and journey through the canal is an important developmental milestone. Books report that during the birthing process, a baby receives proprioception which then helps the brain to learn self-regulation [25, 26]. Moreover, websites like pregnancy-and-giving-birth.com; naturallysavvy.com; livescience.com and caesarean.org.uk, highlight the following advantages of vaginal delivery: the muscles involved in the birth canal help the new born to excrete fluid in the lungs; the birth canal stimulates the baby's cardio-vascular system; it helps to give proprioceptive input they benefit from hormonal surges (endorphin releases); the process is less stressful and they are covered in the mother's good bacteria from the wall of the vaginal canal.

This information has stimulated debate amongst health professionals and the public as to the impact that the mode of delivery has on the development of children and the increased referral to occupational therapy.

CHAPTER TWO – LITERATURE REVIEW

2.1 Introduction

Studies have been inconclusive regarding the causes of learning difficulties, but there is an increasing referral of children with learning difficulties, making up a high percentage of the occupational therapists' workload in paediatric practice. It is important to know causes and risk factors, to ensure early detection and intervention.

The literature review will thus consider the various aspects of non-verbal learning disorders: exploring the development of visual perception and school based skills, review non-verbal learning disorders, including the epidemiology and aetiology of learning disorders, in particular the influence of perinatal factors (low gestational age, low birth weight and mode of delivery). The health of children on the effect on learning disorders will also be explored.

The diagnosis and assessment of learning difficulties will be reviewed, including factors that influence the diagnosis of learning difficulties, followed by the treatment of learning disorders. In this section the focus will be on the importance of the team approach and specifically on the role of the occupational therapist in the treatment of learning disorders. The various tests available that occupational therapists use to diagnose learning disorders will be discussed and in particular the Beery VMI as a useful test for research purposes.

2.2 Normal development of visual perception and school based skills

Visual perception is a developmental process reliant on intact vision. Vision is a dynamic interaction of sensory stimuli including proprioception, kinaesthesia, vestibular and auditory input [27]. Visual perception is the term used for this conscious analysis and interpretation of visual stimuli [3]. It is estimated that 70% of sensory inputs relate to vision with all lobes of the brain being active when processing visual perception. However, the conscious analysis of vision

occurs in the prefrontal cortex [27]. Thus visual perception entails both conscious cognitive processing and interpretation of visual-spatial sensory inputs [27].

The development of visual perception is dependent on learning. Warren (1993) developed a hierarchy of the development of visual perception which encompasses visual skills and cognitive functions related to vision. In this model, visual cognitive functions include visual attention, visual memory, visual imagery (the ability to form a picture in the mind's eye) and visual discrimination (the ability to determine the precise characteristics of a shape) [28].

A child with learning difficulties will have difficulty with visual cognitive functions and therefore, for example, noticing differences in letter orientation for good reading skills would be a problem. In addition, spatial concepts are foundational for mathematical skills. Visuo-spatial short-term memory is foundational for mathematical skills [29]. Pattern recognition and block manipulation tasks have been linked to arithmetic ability. The ability to retrieve arithmetic combinations quickly and automatically was noted by Gersten, Jordan and Flojo as being critical to underlying mathematical learning [30]. Other skills include working memory, logic, planning and understanding of arithmetic operations [31].

Visual perception is divided into object and spatial categories. Object perception is the ability to identify a design despite a difference in size or position in space (form constancy), to identify objects or forms when only partially visible (visual closure) and to be able to distinguish the foreground from the background (figure-ground perception). While object perception occurs in the temporal lobe, spatial perception occurs in the parietal lobe. Spatial perception consists of position in space, depth perception, topographical orientation and spatial relations forming the ability to determine where two or more objects are placed in relation to one-self and to each other [3]. Spatial perception is important for directional aspects of language

including prepositions, the sequence of letters and the ability to differentiate between letters like “b” and “d” [28].

Visual motor integration is the ability to combine and co-ordinate perception and fine motor skills [3]. Thus the assessment of VMI gives information on both the individual’s fine motor co-ordination skills and visual perceptual ability.

Fine motor co-ordination as a component of VMI refers to the dexterity of the hand and fingers in unilateral and bilateral tasks. Eye-hand co-ordination refers to how well one’s hands and eyes function together to produce co-ordinated movement [4]. Fine motor developmental occurs from proximal to distal, from gross or mass action to the integration of a movement to allow for specific tasks. Therefore the development of fine finger activity occurs last. Conscious movement is initiated in the frontal and parietal lobes (motor cortex), with the cerebellum being responsible for smooth co-ordinate movements [3]. The development of refined fine and gross motor skills depends upon good integration of sensory processing within the body [32]. Eye-hand co-ordination, is thought of as an end product of sensory integration (SI), particularly vestibular, proprioceptive, tactile and visual input [33].

Fine motor difficulties are characterised by a lack of sensory awareness, decreased co-ordination and unskilled tool usage, and functional hand problems when vision is occluded. Impairment in fine motor functioning can be significant because it interferes with the child’s ability to do manipulative tasks necessary for cutting, drawing and colouring in [4]. When a child has difficulty with fine motor skills, this restricts the ease with which a child can learn. Proficiency in fine motor skills enables a child to focus on academic concepts during school (for example: creative writing).

Visual motor integration is a foundation skill when copying forms and drawings, letters and numbers. It is the ability to integrate both the visual skills and the motor skills, where the child must first be visually aware of the location and direction of the form and then be able to execute the motor output of copying the design [34]. This entails voluntary eye movement of the stimulus, fine motor ability and eye hand co-ordination when drawing the design [3].

Between the ages of five to ten years, the Euclidean spatial dimensions are developed. These include directionality, lengths, distances and the development of rectilinear and curvilinear lines. During this stage projective spatial achievement (the ability to view objects in relation to other objects and from different points of view) begins to develop and continues to develop [3].These abstract visual perceptual skills are important for the scholastic skills such as design, model building and geometric principles. Visual motor integration along with the development of language, spelling and phonological attributes are all foundational to learning to write, with writing and reading developing in parallel with one another [34]. Visual motor integration skills have been found to be the best predictor of the ability to develop the skill of handwriting [34].

Studies have also found a significant relationship between visual-motor delays and the visual memory and visual-spatial relationship subtests of the TVPS (Test of Visual Perceptual Skills).Research has also found a correlation between the scores on the Beery VMI tests and non-verbal learning difficulties [3].

Visual perception influences school performance. Visual perception forms part of the prerequisite skills for school related activities; namely, reading, spelling, written output, VMI and mathematics. With as much as 30% - 60% of the school day is spent utilizing vision in the form of reading, writing, computer work and other desk top activities. VMI incorporates both the visual perception and fine motor components of these activities of daily living (ADL) [28]. Therefore visual perception impacts a child's performance in occupations including ADL skills, play, leisure and social participation. Dysfunction in these areas can have serious implications in adulthood.

Most importantly, a child's academic performance at a school going age is the most important indicator of their development overall [3]. There is thus a major focus on the detection of learning disorders at this age. Visual perception is therefore an important indicator of non-verbal learning difficulties and must be

evaluated thoroughly in the early years to ensure detection of any developmental delay. Learning disorders will now be discussed in detail.

2.3 Learning disorders

Children with learning difficulties comprise a large portion of the work load of an occupational therapist in paediatric practice and therefore it is of great importance that occupational therapists understand this condition. Learning difficulties can lead to behavioural and social problems with children dropping out of school when older. Therefore early diagnosis and intervention can help prevent these secondary problems from occurring [24, 35].

Learning Disorders relate to the brain's inability to receive, manipulate and store information [21]. A child with a learning difficulty can present without any mental retardation or motor, emotional, cultural or economic disadvantage. These children tend to learn slower than other children presenting with impairments in their school performance [21, 27].Learning difficulties not only impact on schooling, but they are life-long disorders that impact an individual's ADL at various stages of development and can lead to social and emotional difficulties [36, 37].

Learning disorders are considered neuro-developmental disorders [36] characterised by underachievement in a child's ability to speak, listen, read, write or develop the mathematical and language skills expected of them even though they had the opportunity to learn and develop these skills and despite scoring within the normal range in intelligence tests [1, 21, 24]. Thus children with learning disorders are often prevented from reaching their full academic potential [24].

Environmental and cultural disadvantages, emotional disturbances, neuro-cognitive and sensory (visual or hearing) and motor impairments must be excluded when diagnosing a learning difficulty [35]. However, research has found that these children may also have difficulty with social skills and motor-coordination [24].

Studies exploring the relationship between motor planning / motor skill and learning disorders have found that subjects with developmental dyslexia have implicit motor planning deficits which could relate to cerebellar functioning [38]. Other studies have also found that learning disorders are associated with neurological soft signs, including motor, sensory and integrative dysfunctions that are not related to any brain abnormalities and therefore soft neurological signs often go unnoticed. Previous research has estimated that approximately 5% of school children exhibit two or more neurological soft signs with research showing that 7,9% of children who have experienced perinatal birth complications have neurological soft signs [39].

There are variations in the research literature with regards to the categorisation of learning difficulties, which could relate to the numerous difficulties that fall under this umbrella term. There are two subtypes of learning disorders explored in literature: verbal learning disorders and non-verbal learning disorders [35, 40]. The verbal learning disorder encompasses difficulties in language skills, namely reading, writing and spoken language. Children with non-verbal learning disorders have visual-spatial difficulties affecting arithmetic [35, 40].

Symptoms of learning disorders are highlighted in the following academic tasks: effortful, slow and inaccurate reading, written expression that is intelligible and poor mathematical understanding with academic skills being significantly below in tests that are environmentally and culturally appropriate and thus significantly impede their ADL, particularly school achievement [36, 41].

Within these two categories of learning disorders there are specific learning difficulties. The DSMV categorizes learning disorders based on the specific academic subject: namely as a reading disorder, mathematics disorder and a disorder of written expression. According to the DSMV an individual's scholastic achievement and scores on standardised tests in a particular skill, like reading accuracy and comprehension, must be substantially below their ability as predicted by a Standardised Intelligence Quotient (IQ) test. These

difficulties must impact the individual's ADL. The diagnosis of a learning disorder not otherwise specified, covers learning disorders that do not meet these specific academic symptoms but rather any or all three subject areas may be impacted [1]. A learning disorder is thus not a single difficulty but a general category composed of learning difficulties [1, 21,40].

Occupational therapists that specialise in paediatrics frequently assess and treat individuals with learning disorders, in particular non-verbal learning disorders. Occupational therapy treatment of learning disorders focuses on the underlying skills of visual perception, VMI, SI processing, postural control, gross and fine motor control and ADL (including educational tasks of reading, writing and mathematical concepts forming the precursor to instrumental ADL) [42].

Non-verbal learning difficulties are characterised by impairment in visual perception including spatial cognition and object perception, impacting mathematical performance. In a recent study it was found that children who had visual deficits were also non-proficient readers and scored significantly poorer academically [28]. Other research has found that children with a weak ability to master number combinations scored poorly in pattern recognition and block manipulation tasks. This poor ability to retrieve arithmetic combinations (dyscalculia) quickly and automatically was noted by Gersten, Jordan and Flojo as being critical to underlying mathematical learning difficulties [30]. Poor visuo-spatial short-term memory also impacts mathematical skills [29]. Other skills impacting mathematical concepts include poor working memory, logic, planning and poor understanding of arithmetic operations [31].Studies have found that out of the sample of children with learning disorders, 50-60% had language dysfunction and 50% had sensori-motor dysfunction foundation to visual perception and nonverbal learning as the basis of the learning disorder [43].

Research has indicated a link between visual perceptual processing and later non-verbal learning difficulties. Thus visual perception is an area that can be used to predict school readiness as visual perception forms part of the

prerequisite skills for school related activities (spelling, reading, written expression, VMI and mathematics) [28]. Therefore, due to the link between visual perception and later non-verbal learning difficulties, testing of children aged between five and seven years is important in identifying non-verbal learning disorders.

Non-verbal learning difficulties often only become evident at primary school and therefore it is important that research on perinatal birth factors include children of school age and beyond. Thus in this research children from the ages of five to seven years were selected.

Research has found that learning difficulties become more evident as schooling progresses even in children who had no difficulties in their first-year of formative schooling. A study in the USA found that only 28.7% of children with learning difficulties were diagnosed before five-years. Similarly in the Netherlands, therapeutic intervention increased from 1% in five-year old children to 6% in nine-year old children. Thus research with children with a range of ages is more predictive of learning difficulties. Research has found that delays in development (neuro-motor and language delay) and ADHD were the most frequent risk factors in relation to learning disorders [40, 44]. Thus evaluation of concentration, neuro-motor and developmental milestones by occupational therapists are important to predict the possible risk of later learning difficulties.

Reading is the interpretation of written text, which is fundamental to learning and education. This is a neurologically complex skill that involves a variety of cognitive processes including letter recognition and naming, word recognition and comprehension. The term given for a poor ability to read is Dyslexia, which is a specific learning difficulty. It can occur despite the person having average intelligence, educational opportunity and with no socio-cultural disadvantages [36]. It is the most common type of learning disorder which affects about 80% of children diagnosed with a learning difficulty [24]. In the literature, definitions for dyslexia vary; however there is consensus regarding the language basis of dyslexia and thus dyslexia is characterised by reading,

writing and spelling difficulties. This could be due to the unique presentation of symptoms for each individual. [24].

In 2003 the definition for dyslexia was expanded by the British Dyslexia Association to include poor word encoding and word decoding abilities, which are the result of diminished phonological processing of language and these abilities impact on comprehension skills, spelling, vocabulary, writing skills and general knowledge. Decoding and encoding entails determining the sound of the word (word recognition) and also determining the letters that constitute a word (spelling/ dysgraphia). The difficulties experienced in dyslexia relate to writing language as compared to spoken language where spoken language is heard and written language is seen thus incorporating vision with dyslexia. Underlying visual defects can exaggerate dyslexia; however dyslexia is not primarily a problem with defective vision [36].

The co-morbidity of mental health problems and learning disorders has been well documented, including performance anxiety, social skills deficits, low self-esteem and decreased motivation [24, 40]. Research has found that children with ADD and learning difficulties had an increased risk of experiencing primary headaches, including tension headaches and migraines [45]. Learning disorders can be linked to Attention Deficit Disorder, Developmental Coordination Disorders; and Major Depressive Disorders. Also, working memory deficits may underlie learning difficulties [29, 46]. Attention deficit disorder (ADD) frequently occurs with learning difficulties [35, 47]. Half of all children diagnosed with ADD also present as having motor difficulties; including motor control, attention and perception deficits or developmental coordination disorder diagnosis [35]. One study has questioned whether the same underlying cognitive mechanisms are prevalent in individuals with both ADD and learning difficulties due to their high co-morbidity [48].

The co-morbidity of non-verbal learning disorders and specifically visual perceptual problems impact a child’s occupation in education but also with ADL skills, play, leisure, personality and social participation. The pre-existence of visual perceptual problems can have serious implications in adulthood and

thus it is important that children with visual perceptual difficulties receive intervention. [3].

The transition to adult life for a young person with a severe learning difficulty has been found to be more challenging. Research has found that individual's with learning difficulties are more likely to continue living in their parental home, instead of living independently. They also have greater difficulty becoming employed [37].

2.4 Epidemiology of learning disorders

The rate of learning disorders is approximately 2%-10%of school children [1, 35]; however information of the prevalence of learning disorders in SA is not available. In the USA and United Kingdom (UK) these statistics vary with the prevalence of dyslexia being reported between 5-17% in the USA but range from 3-6% in the UK and range below 1% in China and Japan. The variation in the prevalence of dyslexia can be due to the varying definitions and diagnostic criteria used in different countries.

The increase in English speaking countries could be due to the inconsistency between the relationship of sounds and letters. Studies using neuro-imaging techniques have shown the variation in neural circuits across languages [24, 36]. One study indicated that written language disorders were as frequent as reading disorders, with boys having a higher rate of learning difficulty than girls [49].

While a search of the literature cites numerous articles on the prevalence of dyslexia, there were few articles examining the epidemiology of non-verbal learning disorders. One such article found the prevalence of dyscalculia (non-verbal learning difficulty)to be between 6%-10% of the population [31].

Through research it has become evident that learning difficulties have become a common diagnosis in the paediatric population. Researchers have thus focused several studies on trying to find the cause of this high prevalence.

2.5 Aetiology of learning disorders

Learning disorders have their origins in genetic and environmental risk factors which influence the child's ability to reach their developmental milestones related to learning, with different symptoms emerging at different stages in development. For example, a child who has difficulty learning the names of colours can later have difficulty learning letter names and then have difficulty decoding words [23].

Although there is evidence highlighting both genetic and environmental factors influencing the development of learning disorders; the leading theory in the aetiology of learning difficulties reports the aetiology to be multi-faceted [23, 24].

Other research has also found evidence for the genetic cause of learning disorders. Research has found that 23-65% of children born with dyslexia have a family history of dyslexia, with different symptoms of dyslexia within the same family. Other studies have found that chromosomal abnormalities/ heritability account for between 35-50% of the cases of learning difficulties [37, 40]. Dyslexia has been found to be more prevalent in families who have a history of autoimmune disease. Although dyslexia is often inherited, it may also exist in the absence of a family history [24].

The environment impacts brain development throughout life [23]. Environmental factors influencing school performance include prenatal, perinatal and postnatal factors (poor nutrition, neonatal illness, gender and interval complications) [44].

Prenatal factors include intrauterine infection and toxins, neuro-anatomical abnormalities, maternal poor nutrition, maternal stress, family genetics and the use of illicit substances and alcohol by the mother during pregnancy [6, 36, 37, 40]. Perinatal birthing factors include prematurity and birth asphyxia [37]. Infants born preterm have an increased risk for central nervous system damage, increased rate of hypertension and diabetes [6]. Studies which evaluated children born after 32 weeks and the child's school performance as

compared with children born full-term, highlighted that birth weight and gestational age were associated with later learning difficulties [14, 50-52].

Delivering an infant via a normal vaginal delivery, ELCS and an emergency caesarean section (EMCS) have been shown to impact the outcomes of the mother and the infant. Other perinatal complications including prolonged labour, breech delivery, the use of forceps, caesarean section, assisted delivery and jaundice have also been identified in children with coordination and sensory processing problems related to learning disorders, and these are implicated as possible aetiological factors with this group [20].

Included in the prenatal and perinatal factors is the effect of the environment on health of the mother whilst pregnant. This could be influenced by maternal stress caused by various factors including poverty. Postnatal factors include infection, trauma, epilepsy, poor nutrition, related to poverty [37].

Poverty, caused by biological and psychosocial disadvantages, is also considered a risk factor for intellectual functioning. Psychosocial factors impacting children who live in poverty include emotional, social, psychological and financial disadvantages as parents who live in poverty find it difficult to provide optimal emotional, financial and physical care, (including nutrition) to their children and a physical environment that is not crowded, safe and hygienic. Children who experience these psychological factors of poverty in addition to those with biological risks such as late preterm may amplify the risk of learning difficulties and impact on later educational attainment [44, 53] . South Africa has high levels of poverty which elevates the risk of learning difficulties [54].Not only do perinatal birth factors but also socio-demographic factors play a role in later school outcomes [55]. As poverty has an impact on learning difficulties it is important to exclude factors relating to poverty when researching this topic. Thus in this research only children with and without learning difficulties, born in the South African private health sector attending private schools in the Northern Suburbs of Johannesburg were included.

Previous studies suggested that there should be renewed focus on the aetiology of learning disorders focusing on the continued emphasis on the

genetic aspects along with multi-disciplinary and multi-modal approaches to learning disorders, which will aid in providing more information on the behavioural and neurological symptoms of learning disorders [56]. Emphasis has been placed on research being obtained from diverse cultural (including linguistic diversity) and socio-economic populations and from samples that include a variety of age groups to further enhance the understanding and treatment of learning disorders [56]. Thus research will improve the early identification of learning difficulties that subsequently will improve prognosis, and will lessen the impact of low self-esteem and low motivation and poor achievement of children with learning difficulties throughout schooling [21, 22].

Learning difficulties can be caused by many factors, but due to the scope of this review, perinatal factors will now be discussed.

2.5.1 Definitions of perinatal factors

As discussed in previous sections perinatal factors could be one cause of learning difficulties. Perinatal factors include the last five months of pregnancy and the first month after birth [6]. Perinatal factors linked to learning disorders include prematurity, birth asphyxia [37], low birth weight [39] and mode of delivery [9]. Research has linked perinatal factors to the increased risk of various neurological, medical and psychiatric disorders, for example schizophrenia [57], diabetes, ADHD [58] and hypertension [6]. This section will discuss the various perinatal birth factors and the link between later learning disorders, including the complications during pregnancy, complications of birth, in particular low birth weight and gestational age, the mode of delivery and socio-demographic influences.

This section will focus on prematurity and low birth weight as complications of birth and learning difficulties. For the purposes of this research, extremely low gestational age (ELGA) refers to infants born before 28 weeks and VLGA refers to infants born between 29 and 32 weeks [59]. Late-preterm infants, also referred to as near term, are defined by birth at thirty four weeks and nought days through to thirty six weeks and six days gestation, with some

perimeters of late preterm been defined as between 33-37 weeks [60, 61]. Infants are considered to be term, when they are born from 37 weeks to 41 weeks [62].

2.5.2 Pregnancy

Poor health of mothers during pregnancy has also been found to cause learning difficulties and intellectual disability [63, 64].Prenatal factors include genetic disorders and syndromes, intrauterine infection and toxins, neuro-anatomical abnormalities, maternal poor nutrition, maternal stress during pregnancy, family genetics and the use of illicit substances and alcohol by the mother during pregnancy [6, 36, 37, 40]. Perinatal factors such as pregnancy hypertension, pre-eclampsia, maternal diabetes mellitus, maternal anaemia, maternal poor nutrition, some types of ante-partum haemorrhage/ threatened miscarriages, maternal urinary tract infection, maternal asthma, ELCS, preterm birth and the need for resuscitation at birth have been shown in research to be associated with mild-moderate intellectual disability and learning difficulties [44, 64]. The three most prevalent complications of pregnancy in the third trimester are haemorrhage, hypertension and infection [65].Literature contends that 5.8% of pregnant woman experience pre-eclampsia [66], 20%-30% of all pregnancies experience vaginal bleeding [67] and perinatal infections can increase the occurrence of early labour [68].

A rare but important perinatal factor is breech presentation. This occurs when the baby is not in a cephalic presentation in the birth canal but has rather positioned their foot, buttocks or knee in the birth canal. This occurs in about 3-4% of births [69].

Another factor is poor foetal growth [64]. Studies have found a correlation between mothers' pregnancy weight/age and infants being born with low birth weight. Young mothers with low pregnancy weight are more likely to have infants born with low birth weight [70].Intervals between pregnancies less than one month and more than 59 months are also linked with perinatal complications [71].

As research has found a link between perinatal pregnancy factors and later cognitive impairment, it is important that clinicians obtain information on the health of mother as this could indicate a risk of learning difficulties.

2.5.3 Low gestational age

Not only is maternal health during pregnancy linked to later learning disorders but a review of the literature has documented a link between low gestational age (LGA) and later learning difficulties.

The World Health Organisation's (WHO) recorded rate of preterm birth is from 10% to 18% [72]. Preterm birth accounts between 75-80% of perinatal mortality and these infants are at higher risk of central nervous system damage [6]. A study performed in the USA, found that preterm births rose by 20% between 1990 and 2007, with 84% of preterm birth being between 32-36 weeks [52]. However, most neonatal studies have focused on very low gestational age (VLGA) infants [50, 52]. The few studies available for children who were born between 32-35 weeks, indicate that these children are more at risk of schooling difficulties with a recent study showing that one third these children experienced some form of a learning difficulty [14].

Similarly a study in the USA, found that there were greater education needs among children born between 32 to 36 weeks preterm and prevalent below-average reading skills up to the end of grade two. The infants in this study were presumably healthy with no reported neonatal compromised [14]. Results from one study comparing healthy late preterm infants and healthy term infants found that there was a 10% to 13% increased risk of children requiring special education [73]. Research has also found that the degree of prematurity influences the risk for ADHD proportionally [52].

Changes in brain development have been found when comparing infants born greater than 30 weeks and infants born at term. Infants born greater than 30 weeks are born in a period when rapid brain development is occurring and these infants are also more vulnerable to infection and hypoxia [74]. Very preterm infants have been found to have alterations in the development of the

hippocampus. The hippocampus, which is responsible for verbal and visual memory, undergoes rapid development in the third trimester. Reduction in the size of the hippocampus, particularly in the white matter, in very preterm infants has been found to relate to developmental and cognitive delay in toddlers, children and adolescents including decreased working memory. This was specifically related to spatial working memory [75]. A similar study investigating alterations in the corpus callosum in very preterm infants found that the size of the corpus callosum in very preterm infants was smaller and that there is a relationship between the size of the corpus callosum and later motor and cognitive attainment [74].

As discussed, there are numerous studies indicating a correlation between the cognitive and motor outcomes of very low gestational age; however, there is little known about the developmental risks to children that are born late preterm, because of the assumption that this group of infants carry minimal risk for long-term morbidities [53, 73]. Infants born late preterm are a high proportion of children born preterm [73]. A study done in the Netherlands, found that over 50% of infants were born before 39 weeks gestation had significantly higher risks for pulmonary disorders [76]. Studies relating to the health of late preterm infants, have found that they lack physiological maturity and they have an increased risk of co-morbid conditions and mortality. The rate of infants who are born late preterm suffering from one medical condition is four fold and in addition these infants have three and a half fold risk of having two or more conditions diagnosed. Late preterm infants thus have a limited ability to adapt to environmental stressors [60, 77].

Other problems include apnoea; temperature instability; hypoglycaemia; jaundice; poor feeding and they are more at risk for periventricular leukomalacia. However little is known about the long-term impacts of these morbidities [76, 78].

The vulnerability of the late preterm brain is evident from the fact that the last six to eight weeks of pregnancy is responsible for nearly a 35% increase in brain size of the foetus. As compared to earlier pregnancy, this time period is

marked by a five-fold increase and maturation of white matter, through the formation of dendrite, synaptic junction and inter-neuronal pathways and interconnectivity, including the development of chemical and enzymatic neural processes. This leads to questions as to whether infants born early are at risk for permanent neurological injury [79]. Thus further research into the long term cognitive effects of early term delivery is recommended.

2.5.4 Birth weight

Near birth infants, with low birth weight are increasingly being regarded as having an increased risk for developmental delay. There is a lack of systematic measurement of the cognitive and developmental prognosis of infants born late preterm with low birth weight [61]. This is particularly pertinent to the South African population, where little research has been done into the effects of infants born late preterm and with low birth weight.

Studies examining the relationship between low birth weight and later learning disorders have had varied results which could relate to the different definitions of learning disorders, the sample size and the range of low birth weight [80].Statistics from the WHO regarding child growth standards in developed countries, have recorded the average weight for infants at birth at 3,4kg, with a range of 2,7kg to 4,6kg [72].

There are numerous studies which have found a correlation between children with very low birth weight (less than 1500g) and poor neuro-cognitive functioning including low IQ, specific learning deficits and psychiatric disorders like ADHD [39, 44, 80]. In the USA, a study of premature and VLBW infants found that 12% required specialised education at five years. Of significance was that the other 88% in mainstream education presented with minor neurological impairments and were therefore at risk for later learning difficulties. A similar study on nine year olds found that 19% of children born very prematurely with VLBW required specialised educational assistance and 32% of these children were in mainstream education and were functioning at a grade lower, and 38% were receiving therapeutic intervention [44]. Another

noteworthy significant finding in this study is the high percentage of nine year old children receiving therapy.

In infants born with VLBW, studies have found cranial ultrasound abnormalities with these abnormalities being associated with lowered IQ and visual impairment. Some studies have highlighted deficits with VLBW and visual motor functions. However, few studies have examined low birth weight (less than 2500g) and learning difficulties [80]. One study which did 10 neuropsychological tests (including spatial, language, fine motor, tactile and attention skills in the Wechsler Intelligence Scale for Children, Fifth Edition (WISC-V) on six year olds, found that children with LBW scored significantly below children with normal birth weight in these tests [81]. Similar research has also yielded similar results in six-year old children. Results indicated that low birth weight was linked to an increase in neurological soft signs, subnormal IQ and learning disorders. This study also found an association between the increase in neurological soft signs in children born with LBW and anxiety, depression and aggressive and delinquent behaviours [39]. In another study where children, including the complete scope of LBW, were evaluated at six years and then at eleven years using the Wechsler Intelligence Scale for Children, Revised (WISC-R), found that low birth weight was linked with a risk of mathematics and reading disorders in males but no statistical difference was found in female children. Previous research has found that male children have a greater risk of perinatal complications [80].

Cranial abnormalities have been found in one study done on six year old children with LBW under 2000g. Irregularities included 20% having abnormal neonatal ultra-sounds, 13,8% had intra-ventricular/ germinal matrix haemorrhage and 5,7% had ventricular enlargement [80], thus increasing the risk of lowered IQ and learning difficulties.

2.5.5 Mode of delivery

As seen in above sections, early term delivery and low birth weight have shown a correlation with various complications in childhood, including learning disorders. A search of the current literature shows few studies that have

researched the mode of delivery and later learning difficulties. One such study which compared the influence of breech deliveries and ELCS on future neurological functioning found that infants were initially delayed in their neurological responses, however, at six months of age there was no discrepancy in the infants' development and health [82].

Infants delivered preterm including via caesarean sections are at risk for neuro-developmental problems. EMCS are indicated for the following medical conditions; namely, previous caesarean sections, placenta previa, contracted pelvis, human immunodeficiency virus (HIV) infection or breech presentation [9]. A study in Australia has shown an increased risk for perinatal mortality following a caesarean birth and thus there is a risk to subsequent siblings [69]. Another study also showed that siblings to an older child born via caesarean section were more likely to be born LBW and to have congenital malformations [69].

Research found that the gestational period had a strong relationship with special educational needs, with the severity of the educational problems relating to the degree of prematurity [8]. This research indicates the importance in the timing of ELCS deliveries. In another study they compared children born preterm to those born term and linked the 2005 school census, which records the children with special education needs, with routine birth data. Results indicated that 4,9% of the children attended specialised education, using a large sample size of 407 503 school going children of which 8,4% who had been born prematurely and 4,7% who were born at term, had special education needs. This study also found that children born at 37-39 weeks of gestation were 16 times more likely to have special education needs than children who were born at term. This study showed that there is a higher prevalence of children being born early term than preterm delivery and that there is a higher incidence of children who are born early term requiring special schooling. In view of the results, the researchers recommend that gestation should ideally occur at 40 weeks as even if gestation occurs at 39 weeks, there is a greater risk of special education [8]. However, in medical

practice, caesarean sections are most commonly performed in the 38th week of pregnancy, indicating possible risk of neuro-cognitive development[17].

Many women are opting for ELCS deliveries, without being informed about the potential effect on their children and the woman herself [83]. The risks of caesarean sections relate to maternal complications. These include haemorrhage, infection, pulmonary embolism [83]. Women are also opting for ELCS due to the fear of the risk of disability during normal vaginal delivery. However research has shown that the risk of cerebral palsy as a result of labour during normal vaginal delivery is only 10%. Elective caesareans can prevent this risk by virtue of avoiding labour [83].

Caesarean sections that are done before the onset of labour are linked with higher rates of neonatal morbidity due to respiratory causes [84]. Another risk is the development of allergic rhinitis in childhood [85]. In addition, other risks include infections, foetal jaundice, breastfeeding irregularities, low arousal and poor regulation of body temperature [85].

Studies have shown that the number of women who request a caesarean section birth has increased. A study done in 16 countries as to why women chose an ELCS, discovered two main views: that women had a fear of morbidity, for both the neonate and mother during vaginal births, with this mode of delivery being unpredictable, whereas caesarean births were more predictable. The other view encompassed psychological and physical reasons in relation to a previous birth or an existing medical condition. The views of the respondents from the various countries were similar. The motivation stems from a desire to prevent the potential problems that exist due to vaginal births [86]. However a meta-analysis of literature has shown diminished attachment-forming activities between the mother and infant following caesarean sections, with the effect that these mothers having less positive feelings and will be less likely to breastfeed. This effect of mother-infant bonding appears to disappear by the time the child begins school. Of significance, mothers who give birth via a caesarean section tend to have higher expectations of school performance for their children[69]. Despite this, a study done in China found that between

1993 and 2008 the rate of caesarean sections had escalated by three times in urban areas. The study found that improved socio-economic change was only partly responsible for the caesarean section rate increase and that changes in the health service have influenced this increase [87]. Midwives and obstetricians are a key source of information giving professional guidance to women regarding the mode of delivery and can impact their decision when choosing between a normal vaginal delivery and ELCS. A mother's decision regarding her choice in the mode of delivery is additionally motivated by family, friends, culture and increased access to information through the media. The influence of the media in changing maternity care into a consumer based service has also increased the woman's role in the decision making process when determining the mode of delivery [86].

The effect of anaesthesia on the infant during a caesarean delivery and the possible effect on later learning disorders have also been researched. The concern was that anaesthetics exposed to foetal brains may cause alterations and lasting brain abnormalities. This research found that infants who were administered brief general or regional anaesthesia during a caesarean delivery did not have more of a risk of later learning difficulties, when comparing them to infants who are born by NVD [88]. Another study done to investigate the neurological effect of both ELCS and breech presentation reported that, although there were significant differences in the first five days after birth, there were few differences at 6 months of age between these two groups of infants and those born via a NVD. In addition, this study found no statistical differences in the groups of infants from either the group born with the assistance of general anaesthetic versus an epidural anaesthetic. Of significance is that this study had a small sample size [82] and therefore results should be interpreted with caution.

However, caesarean sections are recommended in breech presentation [69]. Therefore in this case it is optimal to wait until full gestational age before performing the ELCS.

Approximately 5% of all deliveries in the USA are vaginal assisted deliveries. Operative vaginal deliveries require the use of suction cups and forceps in assisting the delivery of the foetus. The use of suction cups to aid vaginal deliveries has become increasingly popular. In recent years numerous studies have been performed with most showing favourable results. Vacuum-assisted vaginal deliveries can cause scalp lacerations, intracranial haemorrhage, subgleal hematomas, hyper-bilirubinemia, cephalohematomas, retinal haemorrhage and facial nerve palsies. The risk of such complications is more common with vacuum than with forceps deliveries. Research has shown that vacuum-assisted vaginal delivery can impact long-term cognitive development [89]. However one study showing a 10-year follow-up evaluation of children delivered at term by spontaneous vaginal delivery and suction delivery showed no differences in perceptual integration, fine- and gross-motor control and behavioural maturity [89].

Another significant cause of disability is due to perinatal birth asphyxia. Perinatal birth asphyxia is any injury occurring during the birthing process resulting in anoxia or ischemia and increased carbon dioxide resulting in a range of neurological injuries including cerebral palsy, epilepsy and mental retardation [90]. A result of severe birth asphyxia is neonatal death. Studies have found that neonates surviving moderate to severe birth asphyxia displaying multi-organ involvement. Apgar scores provide useful prognostic data as low Apgar scores show an increased risk of death and chronic motor disabilities. A study done at an academic hospital in Johannesburg from 2006 to 2011 found that birth asphyxia is common, with low mortality rates, but higher rates with possible disabilities. The study also showed that the predictors of birth outcomes are the mode of delivery, hospital of birth and resuscitation at birth. ELCS were associated with better outcomes [90].

A review of the literature has shown a relationship between various perinatal factors, in particular prematurity and LBW, birth asphyxia and later learning difficulties.

This section has also highlighted the impact of the health of the neonate in influencing the development of later learning disorders. This will be explored in the health of children with learning disorders.

The mode of delivery will also be explored, including caesarean section, assisted vaginal delivery, complications of vaginal delivery (birth asphyxia) and the relationship to later learning difficulties will be evaluated. The definition of an ELCS or early term delivery for the purpose of this study will consider gestation from 37-39 weeks as defined in Mackay et al's study in 2010 [8].

2.6 Health in childhood and the effect on learning disorders

Learning disorders have some of their origins in genetic and environmental risk factors which influence the child reaching developmental milestones related to learning [23]. Many infections and diseases can impact on the normal growth and development of a child [91]. In the USA, a nation-wide survey comparing the incidence of medical conditions by children with learning disorders with children without learning disorder, was found to be significantly higher in children with learning difficulties [92]. Various health conditions in childhood have been associated with learning disorders.

Human immunodeficiency virus and AIDS in children can be the primary infectious cause for learning disorders amongst other developmental disorders [93]. Certain genetic syndromes are associated with learning disorders [23], for example Fragile X syndrome [94] and Williams syndrome [95]. Other diseases like Klinefelter's syndrome and Turner's syndrome are endocrine syndromes that are co-presented with learning disorders [91, 96]. There have also been numerous studies investigating diseases of the immune system and the influence on learning difficulties [97, 98] Certain treatments for childhood cancer, including cranial radiation and certain chemotherapy are known to cause learning difficulties [99]. Learning disorders have been found to be more prevalent in children with epilepsy. Epilepsy can cause the deterioration in brain function which results in learning disorders [100].

The scope of learning difficulties is broad and has received a lot of attention from various health professionals. The aetiology of learning disorders indicates genetic, prenatal, perinatal and environmental influences on the development of learning disorders. Current research supports the early identification and remediation of difficulties of learning [40].

From this section it is clear that learning difficulties are complex in terms of cause and symptoms. It is therefore essential that this disorder is carefully diagnosed and assessed to ensure that the child receives the correct intervention. Different intervention strategies will now be discussed.

2.7 Diagnosis and assessment of learning difficulties

2.8 The treatment of learning disorders

Children with weak prerequisite skills not only progress at a slower rate academically, but also have weaker academic performance as compared with their peers. With the aid of early therapeutic identification resources, the treatment of these underlying skills and the prevention of learning difficulties can be addressed. It is therefore important that early recognition and referral to qualified professionals for evidenced based evaluations occurs [24].

Learning difficulties are complex and the solution to addressing learning difficulties are multi-factorial [24]. The treatment of learning difficulties is addressed by teamwork of both health and educational professionals including paediatricians, occupational therapists, educational psychologists, speech therapists, physiotherapists and paediatric optometrists. When assessing a learning difficulty a team approach is used to diagnose the areas of weakness.

For the remediation of learning difficulties, the speech therapist's role is to treat verbal learning difficulties [101], whereas the role of the occupational therapist is to treat learning disorders through graded activities that provide the just right challenge [27, 34] to treat the causes of both verbal and non-verbal learning difficulties [42]. The treatment approaches used by occupational therapists will further discussed elsewhere in the literature review. The role of

the physiotherapist is to treat the underlying motor co-ordination difficulties relating to learning difficulties [102, 103]. The treatment frames of reference used in both occupational therapy and physiotherapy are based on research by Piaget and Gesell who highlighted that the development of sensori-motor skills forms the foundation for the later development of perception and cognition. Other occupational therapy frames of references have been proposed by various authors (Kephart and Roach (1969), Frostig (1970) and Ayres (1972), highlighting the relationship between learning and movement, balance and neural SI. Subsequent research has also found an association between the therapeutic intervention in foundational sensori-motor skills and the improvement of learning [43].

The educational psychologist's role in the treatment of learning disorders is to address emotional and social related difficulties related to school performance. The remedial therapist's role is to aid in the remediation of the scholastic tasks of reading, writing and arithmetic [104].

Literature has found that the role of the paediatrician in learning difficulties is to exclude and manage medical and behavioural co-morbid conditions, refer to the relevant team members to address the learning difficulties and to communicate the diagnosis to the child's school [105]. An Australian study which examined more than 8000 patients of paediatricians, concluded that the most frequent diagnostic assessments were for ADHD and infant development and then for learning difficulties, with consultation time for learning difficulties being the longest [105].

As non-verbal learning difficulties are not caused by anomalies of visual acuity, optometrists don't treat learning difficulties but rather treat any visual abnormalities that may be impacting the child functioning [24, 106]. Optometry treatment includes the use of tinted lenses and coloured overlays for refractive errors, vision therapy and treatment for binocular vision with lenses [36]. In the literature there is varied support for the efficacy of vision therapy, eye exercises or tinted filters/lenses, with the American Academy of Paediatrics not endorsing this type of therapy [24].

2.9 Role of the occupational therapist

Occupational therapists working in paediatrics frequently assess and treat individuals with learning disorders. Occupational therapy treatment of learning disorders focuses on the underlying skills of visual perception, VMI, SI processing, postural control, gross and fine motor control as the internal platform for ADL [42].

Approaches to the intervention of learning difficulties include the use of developmental approaches, behavioural or learning approaches, sensori-motor approaches, SI and the coping theory [27].

Using a developmental approach in treatment is fundamental to occupational practice and theory. Occupational therapy uses various developmental theories that typically describe the sequence of development of motor, sensory, psychosocial and cognitive processes and as a foundation to the treatment of children [28].

Difficulties with visual perception negatively influences functioning in all tasks of occupational performance. In children this would particularly impact their ability to achieve age related tasks and their participation in school related activities, play, leisure activities and thus would also negatively impact on self-esteem. The aim of the therapy is to incorporate a Visual Perceptual Frame of Reference into the treatment of underlying visual perceptual difficulties and the functional outcomes of visual perception [28, 107].

Frames of references that incorporate the behavioural/ learning approach include the Four-Quadrant model of facilitated learning and the Acquisitional Frame of Reference [28]. Occupational therapists use theses frames of reference as a theoretical basis to treat these foundational skills necessary for writing, reading and mathematics. Both of these frames of reference use teaching as a strategy to facilitate learning. The Acquisitional Frame of Reference provides occupational therapists with the theoretical basis for the treatment of skill acquisition through the use of therapeutic activities [28]. Occupational therapists guide the child to develop new skills by using the environment and activities to encourage the learning and mastery of skills/

behaviour. Mastery of a skill will then encourage generalisation of the skill in the child's ADL. Where occupational therapists use the theoretical postulates of the Acquisition Frame of Reference to adapt the environment and for activity analysis to promote learning, they use the Four-Quadrant Model of Facilitated Learning as a means of co-ordinating various learning strategies. With these Frames of References for learning, occupational therapists can enhance a child's skills repertoire through adaption of the activity and environment and through learning strategies and thus enhance the child's occupational performance in the class setting [28]. In addition, occupational therapists incorporate the Coping Theory as part of the treatment for children who have poor coping skills when adapting to environmental stressors [27]. Coping is the ability to adapt to either internal or external environmental events impacted by our values and beliefs. There is a higher incidence of poor coping in children with learning disorders. The coping process involves the ability to give meaning to an event, to then plan the response, implement the action plan (which can be either cognitive, affective or a physical response) and then evaluate the response [27].

Another approach to the treatment of learning difficulties in occupational therapy is SI. Occupational therapist, Ayres (1972) initially developed SI theory for children who have learning disorders. SI theory is intended to explain the difficulties a child is experiencing in both learning and behaviour.

Ayres developed a theoretical framework of SI based on the hypothesis that children with learning disorders show some alteration in their neural processing. Sensory integration theory hypothesises that due to this alteration in neural processing in children with learning disorders; they also have sensory processing and integration disorders, which impact on learning and behaviour. It is this faulty integration and the inability to modulate both sensory and motor information which impact on learning [108]. A deficiency in this integration of sensory information at critical periods interferes with optimal development of the brain and therefore overall function in ADL [109].

Later research has shown that through meaningful sensory motor activities, neural plasticity occurs on a structural, molecular and cellular level (Merzenich et al., 1984; Greenough et al., 1987; Kandel and Jessell, 1995; Kempermann and Gage, 1999; Mckensie, et al. 2003). Occupational therapists adhere to a set of principles within the theoretical framework of SI [108].

Various occupational therapy sensory based treatment approaches and programs including water-based intervention, hippo-therapy (therapeutic activities included in horse riding), therapeutic listening (auditory and SI through sound), the alert program for self-regulation and the use of farm-based intervention have been found to be beneficial in the treatment of learning difficulties [27].

Many children with learning difficulties have underlying sensory integrative dysfunction [27]. Ayres hypothesised that sensory integrative therapy provides sensory inputs to develop normal SI and thus problems caused by the SI dysfunction are alleviated [23]. Ayres encouraged a multi-model approach to the treatment of learning difficulties using an Occupational Frame of Reference (Ayres 1972, 1979, 1989) and thus functional abilities and skills are utilised during therapy [109].

Other occupational therapists have also suggested a multi-model approach to be more effective to treating learning difficulties [110]. Thus occupational therapists use various frames of reference and treatment approaches at different stages of the therapeutic process in the treatment of learning disorders. The first stage of the therapeutic process involves a comprehensive assessment, which will now be explored.

2.9.1 Comprehensive assessment

All preterm infants are at risk for poorer school outcomes and research has recommended early screening and treatment of difficulties [50]. Current research supports the early identification and remediation of difficulties of learning [40].

Literature contends that a multidisciplinary approach is the best approach in diagnosing learning disorders [35, 41]. Diagnosis of learning disorders is made according to the DSMV. A battery of tests and clinical reviews are used when determining a specific learning disorder, where the individual's educational, medical, developmental and family history is reviewed. These include a neurological examination and psycho-educational tests, schooling performance (including teacher observations) and the individual's response to therapeutic interventions [23].

The development of a number of valid and reliable measures that can predict and screen which learner is likely to have learning difficulties have evolved over the last 20 years [30].

However, studies on children with learning difficulties have generally been limited to the use of standardised psychological tests and standardised academic tests [27].

The results of a study done on identical twins found that the assessment of IQ is more relevant than environmental influences for the diagnosis of reading disorders [111]. One such IQ assessment is the WISC. The WISC is a battery of subtests administered by an educational psychologist. Research has found that the WISCV is a reliable assessment tool for learning disorders. This test has also shown reliability when assessing working memory, in particular visuo-spatial working memory [46]. Although IQ tests diagnose severe disorders, they do not identify certain subtle foundational perceptual and language problems which occupational therapy and speech therapy assess and treat [27]. The Beery VMI which is used extensively by occupational therapists correlates moderately with intelligence tests as it is a test of not only visual but also motor development and as such appears to be more sensitive to these neuropsychological problems [3]. It is thus important for occupational therapists to use all three subtests of the VMI, which includes the visual motor integration test, visual perceptual test, and motor coordination test.

As part of the multi-disciplinary team assessing and treating individual's with learning disorders, it is important that occupational therapists utilise

assessments with high validity, reliability and clinical application [107]. Early detection of scholars needing therapeutic intervention is dependent on reliable screening tools. For screening tools to be effective, they must relate to the educational system [42].

Occupational therapists have a range of tools to screen and assess the prerequisite skills that may be deficient in learning difficulties. These include assessing the underlying skills of visual perception, VMI, sensory-integration processing, postural control, gross and fine motor control and ADL.

When assessing for learning difficulties, a detailed history of pre-natal, peri-natal and post-natal risk factors along with a medical history of the child's health is recorded. The diagnosis is concluded from the assessment of the child's visual processing, includes the evaluation of the child's visual-motor skills, visual-spatial skills, short-term visual memory and analysis of auditory – perceptual skills (test for auditory – perceptual skills) [42].

A number of visual perceptual tests have been designed and revised including the Developmental Test of Visual Perception-2 (DTVP-2), the Test of Visual Perceptual Skills- Revised (TVPS), the Test of Visual-Motor Skills (TVMS), the Motor Free Test of Visual Perception-Revised (MVPT) and the Beery Developmental Test of Visual Motor Integration (Beery VMI). Other standardised assessments frequently used by occupational therapists include the SI and Praxis Test, The Bruininks-Oseretsky Test of Motor Proficiency (BOTMP), Peabody Developmental Motor Scales (PDMS), Bayley Scales of Infant Development, Good-Enough Harris Draw-a-Man Test and the Miller Assessment of Preschoolers (MAP). These tests include measurement properties of validity, reliability and clinical utility. Occupational therapists also use clinical observations (Ayres) and informal observations. A number of studies done have found that the most common and reliable assessments used by occupational therapists when assessing perception are the Beery VMI, MVPT and the TVPS. When choosing the Beery VMI, MVPT and TVPS tests, the ease of use, previous academic training in the test, the skills which need to be evaluated, previous relevant experience, partiality towards a

specific test and accessibility were all important factors. The TVPS and the MVPT tests were used to confirm the diagnosis, set treatment goals and for reassessment. The Beery VMI was used predominantly as a screening tool and for reassessment [107].

The DTVP-2 assesses visual perception and visual-motor difficulties in children aged 4-10 years. The testing time is between 30 to 60 minutes. In terms of reliability and validity, the test-retest inter-rater reliability is .97 and the DTVP-2 correlates .78 to the MVPT.

Other tests that have been developed to assess VMI have been the Test of Visual-Motor Integration (TVMI) and the Bender-Gestalt 2. The TVMI has been based on the copying subtest of the DTVP-2; however this test has lower inter-scorer reliability with poorer correlation to chronological age and academic achievement. Like the Beery VMI, the Bender-Gestalt assesses the copying of geometric shapes. It takes longer to administer and score than the Beery VMI.

The Motor-Free Visual Perceptual Test, third edition (MVPT-3) is a test of visual perception without a motor component. The sample size consisted of 2005 children with the test's internal consistency scores were between .69 and .87 between the ages of 4-10 years and the test-retest reliability was .87. The criterion-related validity was .78 with the DTVP-2 and between .37 and .22 for various subtests of the WISC-3. There is a .41 correlation to related tests of academic achievement [112].

The TVPS-R is a non-culturally biased, non-linguistically, non-motor based test that evaluates seven perceptual sub-skills, including: visual closure: visual form constancy; visual-spatial relationships; visual sequential memory, visual figure ground, visual memory and visual discrimination. The test age ranges from ages 4 to 19 years, whereby the child selects the correct choice from a choice of four or five items per test sheet and the duration is approximately 30-45 minutes. The scoring takes 5-10 minutes. The sample size was 1032 children. The test retest reliability was 0.83-0.91; however there is no data on the intra-rater and inter-rater reliability, thus the TVPS has limited reliability and validity. The concurrent validity is 0.25- 0.45 with the Test of Visual-Motor

Skills-Revised and 0.15 -0.35 correlating to the WISC-3 (picture completion subtest) [107].

The above are commonly used in occupational therapy practice but the Beery VMI has been proven to be a comprehensive and accurate assessment tool. This will now be discussed in detail.

2.9.2 Beery Visual Motor Integration

The Beery VMI was originally developed in 1964, is based on gestalt theories and Piaget's developmental theories and is thus a developmental test. Due to the test having little cultural bias; this test has been used widely in numerous countries for medical treatment, education and for research. It has also been found to be a good predictor of future non-verbal scholastic performance [3]. Research has found a significant correlation between teacher's ratings of their student's reading, writing, mathematics and spelling performance and these student's results on the Beery VMI in seven to nine year olds [113]. Other research has also found a positive correlation between children's performance in academic tests for reading and mathematics and scores in the three subtests of the Beery VMI [114, 115].

Research has found a positive correlation between the Beery VMI assessment scores and handwriting scores for children in kindergarten [116]. The Beery VMI has been standardised on numerous occasions to a total of 11000 children and in 2006 with 1021 adults where consistent results over time and place were obtained, particularly for preschool and for primary grades. The Beery VMI has also been found to obtain consistent scores for both group and individual scoring [3].

The Beery VMI sixth edition consists of a developmental sequence of geometric shapes in a test book, to be imitated or copied with a pencil. The Short Form is available for ages two to seven years and takes on average 10 minutes to administer. When scoring the Beery VMI, a ceiling is reached when three consecutive items are incorrect. The supplementary visual perceptual test consists of 27 stimuli, where the task is to identify one geometric form that

is exactly the same as the testing stimulus in a three-minute period. The children point to the correct answer in a test booklet. The Beery VMI perceptual is also terminated after three incorrect consecutive items. In the Motor Co-ordination subtest, the child has to trace within two paths with a pencil, 27 designs, within five minutes [3].

In the VMI Beery a change of 9.1 points has been reported between typical children and those with a risk of learning difficulties. This change of 9.1 points was based on previous research using the Beery VMI, when testing at a one-sided 0.05 level of significance [3]. The calculation assumes a standard deviation of 15 points for the Beery VMI, as indicated in the Beery VMI User's manual. The Beery VMI displays high level reliability and measures between .80 and .90 levels of validity which remains consistent in numerous studies. The test-retest reliability is .89 for the Beery VMI, .85 for the Visual Perception subtest, .86 for the Motor Coordination subtest. Previous research reported inter-scorer reliabilities of .90 with trained professionals [3]. The Beery VMI manual also reports high content reliability and internal consistency when using the Rasch-Wright measure [3]. However, one study has found that when testing whether the Beery VMI items are developmentally ordered along with differential ordering using the Rasch Measurement Model, the Beery VMI was not consistently sequenced in order of difficulty [117]. The overall reliability of the Beery averages at .92 for the Beery VMI, .91 for Beery VMI Perceptual and .90 for the Beery VMI Motor, indicating high overall reliability.

Construct validity of the Beery VMI correlates well with age, measuring high levels between 0.8 and 0.9. The concurrent validity of the DTVP-2 eye-hand co-ordination subtest and the Beery VMI has been found to be .65 [3].

A survey into what assessments occupational therapists are using to assess handwriting indicated a variety of formal and informal assessment methods have been used, with the Beery VMI and the DTVP-2 being the preferred standardised assessment tools to assess fine motor control [118]. The concurrent validity of the DTVP-2 Copying subtest when compared to the

Beery VMI was .75 and the DTVP-2 Position in Space subtest correlated .62 with the Beery Visual Perceptual Subtest [3].

The Beery VMI has been widely considered the most widely researched test with high validity and reliability for assessing VMI. Added to which, the Beery VMI is a good predictor of future non-verbal ability and reading ability. The fact that the test can be administered in a group setting with consistent results is gender and culture free of bias and the short duration of the test makes it ideal for research purposes [3].

2.10 Conclusion to literature review

As highlighted in the literature review, not only do learning disorders affect academic skills; but also ADL skills, play, leisure and social participation. The literature has supported the DSMV diagnostic criteria and categorisation of learning disorders into verbal and non-verbal learning disorders and explored the impact on functioning in both childhood and adulthood.

Studies have cited that children with learning difficulties are the largest group of learners receiving special education. Of significance for occupational therapists are the impact of non-verbal learning disorders and the role of visual perception in the detection, treatment and prevention of learning difficulties. As evident in the literature, visual perception and VMI are part of the prerequisite skills for reading and mathematics.

The literature review also explored the factors related to learning difficulties highlighting varying explanations regarding the causes of learning disorders. A review of the current literature into the causes of learning disorders has been limited with research being mainly focused on the genetic factors of learning disorders. There are also numerous studies that have researched the link between prematurity, low birth weight and the development of later learning disorders. However, there has been little research exploring the mode of delivery and the link to later learning disorders.

A search of the literature highlighted the importance of early recognition and referral to a team of professionals including paediatricians, psychologists, speech therapists, occupational therapists and remedial therapists.

When exploring the scope of occupational therapists that specialise in paediatrics in the literature, the roles of the occupational therapist includes the assessment and treatment of individuals with learning disorders, in particular non-verbal learning disorders. Occupational therapy treatment of learning disorders focuses on the underlying skills of visual perception related to academic performance, VMI, SI processing, postural control, gross and fine motor control as well as ADL (including reading, writing and mathematical concepts).

The current literature has also reviewed various valid and reliable assessment tools of learning disorders. Screening tools for five, six and seven year old children have been established; in particular the Beery-Buktenica Visual Motor Integration Test (Beery VMI). Research of the Beery VMI indicates high test-retest reliability and will be suitable of the purpose of this research in determining the possible link between the various perinatal factors and future learning difficulties. Through the use of assessment tools, early therapeutic intervention can be given and these deficits can be treated aiding in the minimisation of learning difficulties.

CHAPTER THREE – METHODOLOGY

3.1 Introduction

The following chapter will describe the research methodology used in this study. The study design will be described, then the subjects who participated in the study, the research procedure that was followed and measurements tools used, how the data collection was done, which ethical considerations were taken into account, and finally how data was analysed.

3.2 Study Design

A quantitative descriptive cross sectional design was used as this research. This design is appropriate for this research as the results will produce numerical data to examine if a difference exists in terms of birth factors and VMI in children with or without learning difficulties.

The cross sectional design is appropriate as data has been collected from a population group (children with and without learning difficulties in the Northern Suburbs of Johannesburg) in one point in time to allow inferences to be made from the collected data regarding birth factors and VMI. The research is quantitative as one variable is being compared with another variable and the research is descriptive as the subjects were only measured once.

3.3 Subjects

3.3.1 Study population

Children with and without learning difficulties born in the private health sector attending private schools in the northern suburbs of Johannesburg.

3.3.2 Study sample

Because learning difficulties are complex, and affected by many factors, it must be studied within several contexts to fully understand its causes and impact. Thus due to the diversity of the population within South Africa, a

specific population group was chosen. In this research the study sample was based on geographical location and convenience sampling, as the study particularly focuses on children in the Northern suburbs of Johannesburg.

However; it must be noted that if research is limited to a specific demographic, such as one race, gender or geographical area, it is difficult to apply the findings to a diverse population such as South Africa and therefore the finding must be limited to populations with similar demographics.

The study population consisted of one sample of conveniently selected children from three schools, namely children without learning difficulties from MSS and children with learning difficulties from the SCSN. The selection of children from both the MSS and SCSN was to ensure that different birth factors are included and not limited to one set of children, either with learning difficulties or without learning difficulties. In addition, one specific perinatal birth factor was selected, namely mode of delivery, to investigate whether any differences could be found in terms of the children's' health and their VMI scores. Describing birth factors and VMI scores in children with learning difficulties only, would have limited the study findings, and therefore children without difficulties were included as this enriched the data and results to a wider population.

A power calculator was conducted to determine the sample size required.

The Beery VMI, Beery VMI Visual Perceptual Component and the Beery VMI Motor Co-ordination Component were used to assess and compare the differences between learning difficulties and perinatal birth factors. Not more than three perinatal factors were included in the multi-point testing phase to assess the difference of these factors with learning difficulties. Ideally a sample size of 86 children to include 10-15 participants for each perinatal factor is recommended. This ideal sample size was also adequate to assess whether the two participating groups differ with respect to Beery VMI scores as some of the mainstream children would also be at risk for learning difficulties. In the Beery VMI a change of 9.1 points has been reported between typical children and those with a risk of learning difficulties. A sample size, at 43

participants per group, will have at least 85% power to detect a 9.1 points difference. This analysis was based on research by Foulder-Hughes, and Cooke (2003) using the Beery VMI, when testing at a one-sided 0.05 level of significance. The calculation assumes a standard deviation of 15 for the Beery VMI, reported in the Beery VMI User's manual [3].

Although the ideal sample size was 86 subjects, with this research a total of 47 subjects were tested. An insufficient sample of children was obtained from the initial schools approached; therefore the other three SCSN, Bellavista school, Japari school and Delta Park school for children with special needs were invited to participate in the research; however these schools did not give consent.

A total of 60 five, six and seven year old children from Crawford mainstream school and 22 five, six and seven year old children from Crossroads school and Japari school with learners with special education needs completed the parent consent form. Seven participants from the mainstream school were either born in a public hospital or were not born in the northern suburbs of Johannesburg and some parents did not complete the electronic parent questionnaire, thus 32 children from the MSS were selected. All participants from the SCSN were included in the research.

Therefore, 32 five, six and seven year old children from the selected MSS and 15 five-year old children from the selected SCSN enrolled and met the requirements for this research.

3.3.2.1 Inclusion criteria

- Children aged five years zero months to seven years eleven months and 29 days.
- Children born in the private health care sector in South Africa.
- Children attending MSS and SCSN in the northern suburbs of Johannesburg were included to ensure a variety of perinatal factors will be present in the participants in the sample.

- Consenting primary caregivers.

3.3.2.2 Exclusion Criteria

- Children with any other significant childhood illnesses such as HIV, Cancer, Infectious diseases, Diseases of the immune system, Cardiac diseases, Endocrine diseases and other syndromes.
- Any children who had physical disabilities, particularly in being unable to do a pen and paper test, were excluded.

3.4 Research procedure and data collection

The researcher obtained approval by the Graduate Studies Committee of the Faculty of Health Sciences. In addition ethical clearance from the Human Research Ethics Committee (Medical) (Appendix A) and permission from the Gauteng Department of Education (Appendix B) was obtained. After these clearances were obtained, the different schools were approached and the researcher gave the principals of the schools information letters (Appendix C). Permission to do research was obtained from the principals of the schools who agreed to participate (Appendix D).

Information regarding the research and an invitation to participate in the study was given to the parents of the five, six and seven-year old children at the Crawford schools and Crossroads school by issuing an information letter (Appendix E). The parents gave informed consent (Appendix F) for their children to participate in the study by signing an informed consent sheet, which also required them to give their contact details and email addresses for the questionnaire (Appendix G) to be sent to.

A research assistant, qualified in secretarial work, collected the informed consent forms from the schools. As an insufficient sample of children was obtained from the existing schools; Bellavista school, Japari school and Delta

Park school for children with special needs were invited to participate in the research; however these schools also did not give consent.

The research assistant sent out an electronic parent questionnaire (Appendix G) via an Adobe Forms-central document repository to the children's parents to complete, with 32 parents from the Crawford schools and 15 parents from the SCSN returning the forms, once completed, automatically via email. The information emailed back to Adobe Forms-central automatically categorised the information into tables and graphs of the total sample.

The researcher administered Beery VMI subtests (Appendix H) to these 47 subjects, 32 children from MSS and 15 children from schools with learners with special education needs, assessing approximately 5 children per morning with each screening taking approximately 20 minutes, and these assessments were performed at a time convenient for the children and teachers. The researcher recorded and evaluated the Beery VMI subtests scores for each subject.

The researcher gave feedback to specific parents upon request and in the case of abnormal scores in the Beery VMI; feedback was given electronically and telephonically to the parents. Feedback was also given to the treating therapists if appropriate. Where feedback was given, a list of occupational therapists in the area (who can perform an in-depth assessment and treatment) upon request was given to the parents of children where abnormal scores were recorded.

3.5 Measurement Tools

3.5.1 Parent questionnaire (Appendix G)

This electronic questionnaire was developed by the researcher to collect background information on the child participants' demographic information, their perinatal birth factors and the participants' previous and current health. Thus the parent questionnaire provided information on the following two objectives:

- The perinatal factors between children aged five to seven years in MSS and SCSN. The perinatal factors between children born via normal vaginal delivery, ELCS and emergency caesarean section.
- The previous and current medical history between children aged five to seven years in MSS and SCSN, obtained from the parent questionnaire. The previous and current medical history between children born via normal vaginal delivery, ELCS and emergency caesarean section.

  The information for these objectives were obtained from the parent questionnaire

The parent questionnaire contained a list of questions, which included the children's demographic information, the mode of delivery, if caesarean, whether it was an elective or EMCS and information including the children's prenatal, postnatal and current health status and therapy attendance. The parent questionnaire was assessed to test the content validity, by experts, including occupational therapists, speech therapists, physiotherapists and a medical practitioner. In addition, the parent questionnaire had been reviewed by the Ethical Committee at Wits, who made recommendations to include the following information: question six to include 41 and 41+ weeks in gestation, question seven to include birth head circumference, question17 replaced paediatrician with physician. In addition it was recommended that the following sentence be included on the cover page: "Apgar scores, birth weight and head circumference can be found on the Immunization card."

The development of the parent questionnaire will be discussed in further detail under the pilot study (3.5.2).

3.5.2 Pilot study

A pilot study was performed where the parent questionnaire was reviewed by five experts: including occupational therapists, physiotherapists, speech therapists and a general practitioner in the field of paediatrics, and the questionnaire was adapted according to their remarks.

Suggestions made from the Pilot Study included having both APGAR scores recorded; any surgical procedures; any sucking, swallowing or feeding difficulties; any aversion to taste or texture of foods; parents identity numbers; the number of siblings and their mode of delivery.

The suggestion of including both of the APGAR scores; the number of siblings and the siblings' mode of delivery were included in the demographics. In order to make the parent questionnaire short to promote participation from parents, the suggestion of sucking, swallowing or feeding difficulties and any aversion to taste or texture were excluded. Surgical procedures would be encompassed under hospitalisations.

3.5.3 The Beery-Buktenica Developmental Test of Visual-Motor Integration

The Beery-Buktenica Development Test of Visual-Motor Integration (VMI) is an instrument for the early identification of learning disorders intended to be used as a multi-level screening-diagnosis system [3]. The Beery VMI has been found to have a moderate to high ability to predict later non-verbal learning difficulties [3]. This was also discussed in more detail in the literature review.

The Beery VMI tests used were:

1. **Beery VMI Test - Revised(Appendix H)**

   The VMI subtest consists of a developmental sequence of geometric forms to be imitated or copied in a test booklet with a pencil.

   The testing procedure was as follows:

   Instructions for the Beery VMI included the following: The researcher ensured the booklets were centred with the child's body and the desk. The researcher turned to page four of the booklet. The instruction given by the researcher was as follows: "Make one like that. Make yours right here." If the subject did not understand the instruction, the researcher turned to page 2 and said: "Watch me. I'm going to draw a line here." The researcher

drew the vertical line in the top left box. The researcher pointed to the drawn line and the box below and said: “Make one like that. Make yours right here.” This procedure was repeated with the horizontal line and the circle. If the child scored one or more for the imitation tasks, then the researcher proceeded to page four to allow the child to copy the items again. The researcher prompted as many times as necessary, by saying: “Make this one.” Once the subject was working independently the researcher said: “Good. Go ahead and do the rest of them. Turn to the next page when you finish this one. Do your best on both the easy and hard ones; don’t skip any.” The researcher recorded observations. Testing was ended after three consecutive items did not score.

2. The Beery VMI Visual Perceptual Component Test

The visual perceptual subtest consists of 27 stimuli, where the task is to identify one geometric form that is exactly the same as the testing stimulus in a three-minute period. The children point to the correct answer in a test booklet.

The testing procedure was as follows:

Instructions for the Beery VMI included the following: The researcher ensured the booklets were centred with the child’s body and the desk. The researcher placed one finger on the darkened line in the top box of number four and gave the following instruction: “See this line? There is one more line that is just the same down below. Let’s find it! You point to it!” The researcher made a mark next to the answer given. If no answer was given then a circle would be made on number four. The instruction was repeated for stimulus five and six. From stimulus seven, no further teaching was given. The researcher marked all responses until three consecutive items were incorrect or the time limit had expired.

3. The Beery VMI Motor-Component Test

In the Motor Co-ordination subtest, the task is to trace 27 stimulus designs with a pencil, without going out the double lined pathway within five minutes. Scores were given based on the correct answers given within the time limits, and compared to the normative data in the test manual.

The testing procedure was as follows:

The researcher ensured the booklets were centred with the child's body and the desk. The researcher said: "Watch me draw a dark line from the black dot to the gray dot and try to stay inside the road." The researcher drew a line inside item 4A and then pointed to item 4B saying: "Now you do it. Draw a dark line from the black dot to the gray road." This procedure was repeated for items five and six. At item 7 the researcher then said: "Draw a dark line from the black dots to the gray dots. Try to stay within the road. Go ahead. Do as many as you can. But do not rush. Draw carefully. Draw the forms in order. Don't skip any." The researcher timed from item seven and then when the first page was completed the researcher turned the page saying: "Some forms on this page have only a few dots and some do not have any dots at all. If a form has a black dot, start there, if it has no dot, start wherever you like. Stay within the roads and make each form look like the small example just above it." The test continued until the child finished or the time limit of five minutes expired.

The Beery VMI displays high level reliability and measures between .80 and .90 levels of validity [3].

3.6 Data management

All relevant data was collected from the parent questionnaires and the Beery VMI subtests, and this was collated in a spread-sheet. Data from the

questionnaire was descriptive, and that information was collected in a spread-sheet. The Beery VMI subtests were scored and the total scores were put into a spread-sheet, with formatting done to produce charts and graphs showing the results using Microsoft Excel. Results were extrapolated to produce generalised statistics.

3.7 Ethical considerations

- Ethical clearance (Number M120921) was obtained through the Faculty of Health Sciences of the University of Witwatersrand's Ethical Committee (Appendix A).
- Information letters were sent to the principals of the schools (Appendix C) and permission to perform research was given (Appendix D).
- Information letters were sent to the parents (Appendix E) and they provided informed consent (Appendix F) for their children to participate. All children participating in the study gave verbal assent (Appendix I).
- No names were disclosed on the questionnaires or VMI score sheets and the participants were assigned codes.
- Participants gave verbal assent before assessment commenced, and they were given the option to withdraw from the study without any negative consequences, and if the children were attending therapy at the time of the study, there were no consequences due to withdrawal from study.
- Feedback regarding the test results was made available upon request to the treating therapists and to parents. In the case of abnormal scores and the child was not at the time in therapy, feedback was given to the parents.

3.8 Data analysis

The data obtained from the information in the parental questionnaire, and the scores from the Beery VMI test were not normally distributed due to the small sample size. A non-parametric test was therefore used, namely the Mann Whitney U-test to calculate the differences in pregnancy complications, gestational age, birth weight, and APGAR scores, medical history, attendance to therapy, and Beery VMI scores between the two school groups, and between two modes of delivery at a time.

Information regarding the gestational age, weight at birth, pregnancy complications and sample size of the schools and modes of delivery was obtained through calculation of frequencies. Information was presented through pie charts and bar graphs.

CHAPTER FOUR – RESULTS

4.1 Introduction

The following chapter will describe the results of the study. The data of the total sample will be presented first in terms of the gestational age, weight at birth and pregnancy complications of all participants. The sample size of the two different schools as well as the sample size from the different modes of delivery will be presented. Then the results from comparing the different birth factors and Beery VMI scores of the children from the two different schools will follow, and lastly the comparison between the birth factors and Beery VMI scores of the children born via different modes of delivery.

4.2 Demographic data of total sample

Eighty two parents gave consent for their children to participate in the study. Seven of these children were excluded from the study based on the exclusion criteria.

- Four of these children were born in private hospitals outside Johannesburg.
- Three participants were born in the public health care system.

Forty seven parents completed the electronic parent questionnaire, of which 32 were from the MSS and 15 were from the SCSN. All children were born at private hospitals in Johannesburg. Thus 28 children were further excluded due to their parents not completing the electronic questionnaires.

None of the subjects suffered from the following illnesses: HIV/AIDS; genetic syndromes; cancer; infectious diseases; diseases of the immune system; cardiac diseases; endocrine diseases nor epilepsy, according to the research inclusion and exclusion criteria. No children with any physical disabilities volunteered to participate in the study.

From the total participants 21 were girls and 26 were boys. The total sample comprised of five five-year old children, 25 six-year olds and 17 seven-year olds.

4.2.1 Gestational age

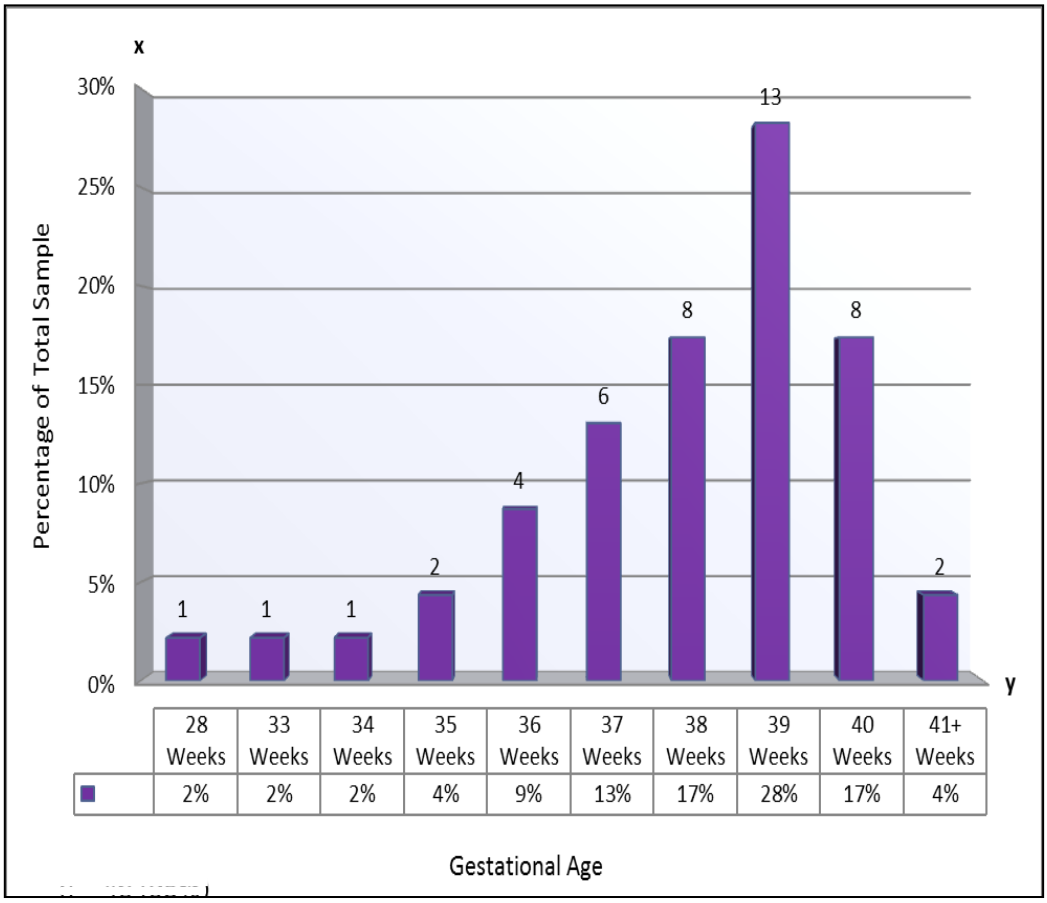


Figure 4.1: Gestational age of participants in the total sample

In this study, 10 (21%) of the subjects were born between 40-41 weeks, 13 (28%) were born at 39 weeks, 8 (17%) were born at 38 weeks, 6 (13%) were born at 37 weeks, 4 (9%) were born at 36 weeks, 4 (8%) were born between 30 -36 weeks and 1 (2%) were born from 28-30 weeks.

4.2.2 Weight at birth

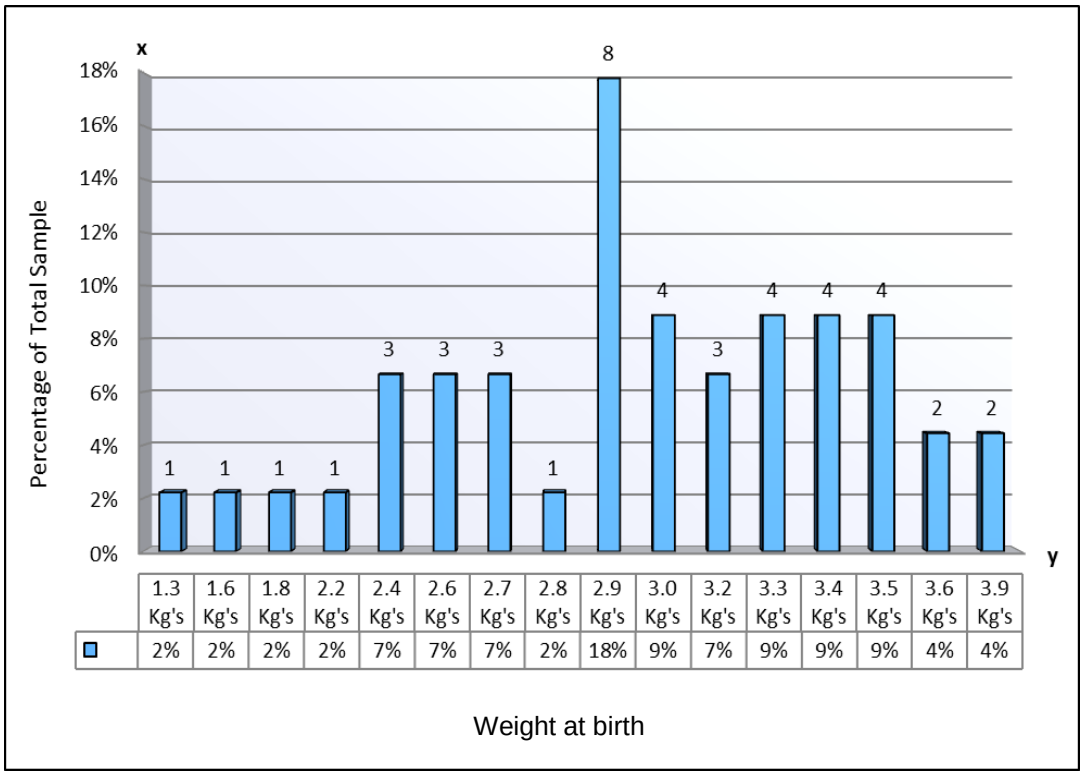


Figure 4.2: Weight at birth of participants in the total sample

In Figure 4.2 it is shown that 34(85%) of the total sample weighed between 2,7kg and 4,6kg; 3 (7%) of the total sample weighed between 2.5kg and 2.7kg; 7 (13%) participants were below 2.5kg and 1 (2%) participant was below 1,5kg.

4.2.3 Pregnancy complications

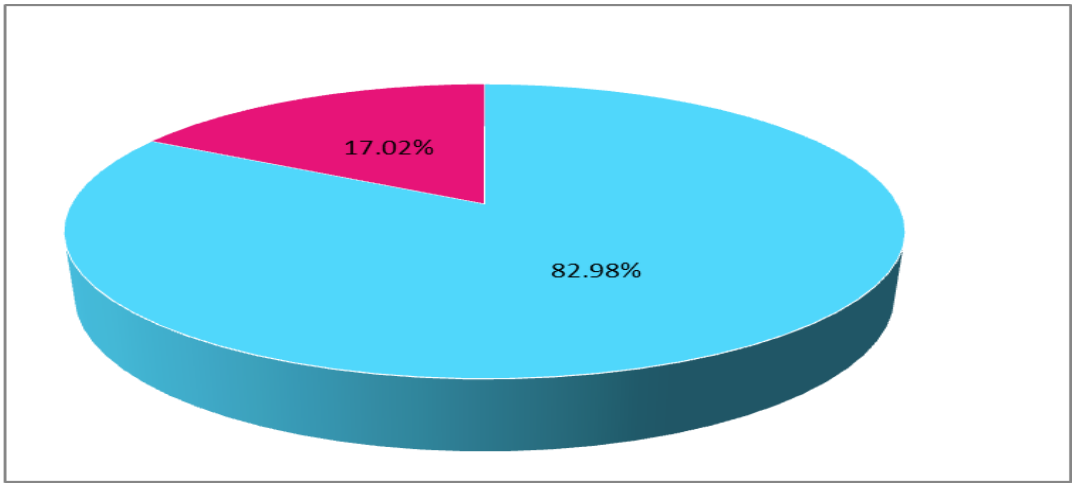


Figure 4.3: Pregnancy complications of mothers of participants in the total sample

The results in Figure 4.3 indicate that 82.98% (n=40) of the mothers of the participants had normal pregnancies and 17.02% (n=8) did not.

Regarding birth complications, 23% (n=11) of the mothers reported complications during birth, and three mothers (6.4%) reported breech presentations.

4.2.4 Sample size from two school groups

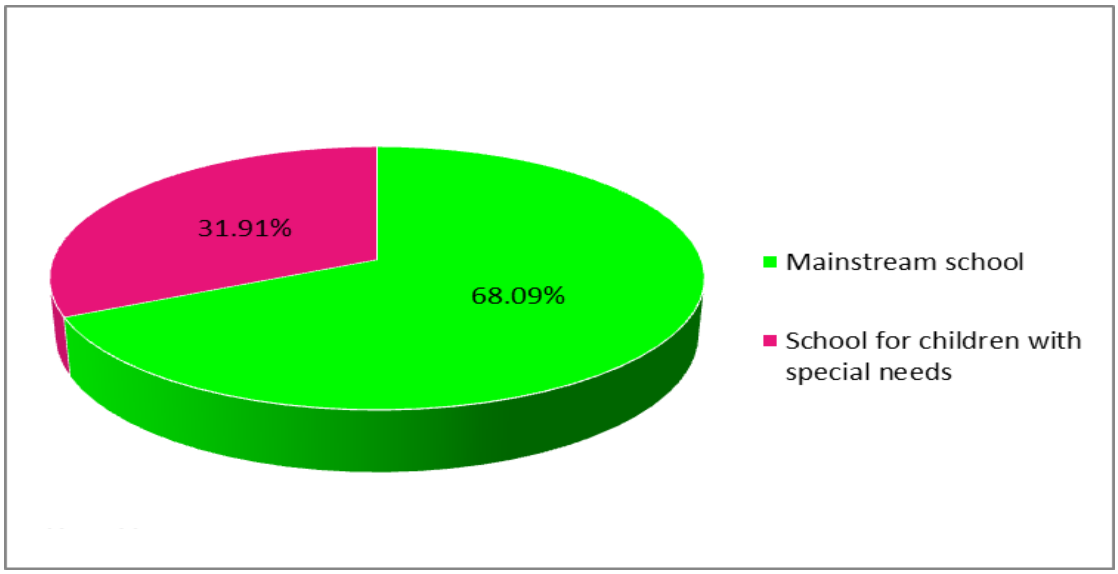


Figure 4.4: Sample sizeof the two school groups

Figure 4.4 illustrates that 68% (n=32) of the total sample was from the MSS and 31.91% (n=15) from the SCSN.

4.2.5 Sample size from different modes of delivery

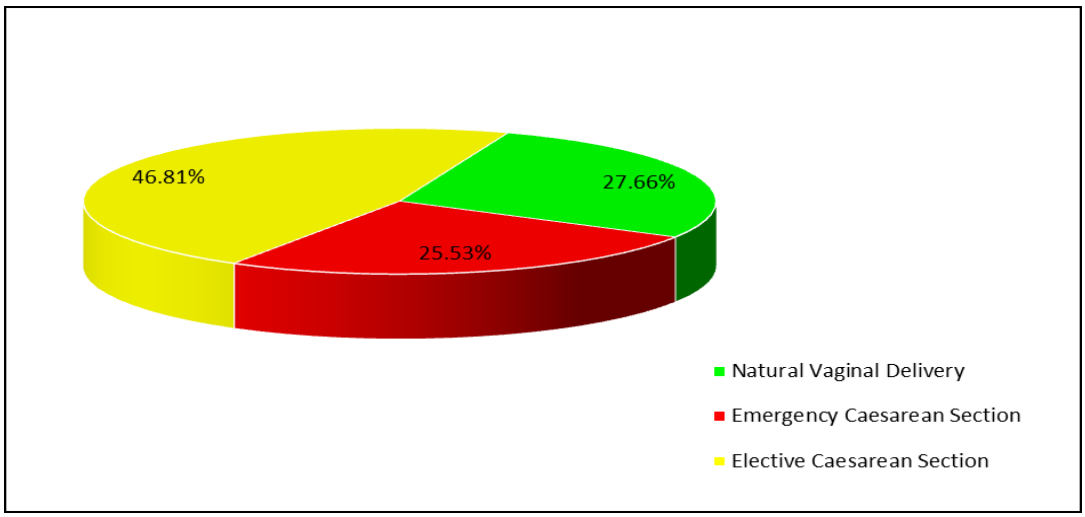


Figure 4.5: Sample size of modes of delivery

The mode of delivery in the total sample of participants is illustrated in Figure 4.5. For the total sample, 27.66% (n=13) were born by normal vaginal delivery and a total of 72.34% born by caesarean section, 46.81% (n=22) of the participants were born by ELCS and 25.53% (n=12) were born by EMCS.

4.3 Differences in perinatal factors between participants in different school groups

4.3.1 Mode of delivery

Table 4.1: Difference in mode of delivery between the school groups

Mode of delivery	Mainstream schools (frequency) (n=32)	Schools for children with special needs (frequency) (n=15)	P Value
Vaginal delivery	10(31.25%)	3(20.00%)	0.609
Elective caesarean section	15(46.88%)	7(46.67%)	
Emergency caesarean section	7(21.88%)	5(33.33%)	

Table 4.1 shows no significant differences between the MSS and the SCSN groups.

4.3.2 Pregnancy complications

Table 4.2: Difference in pregnancy complications between the school groups

Pregnancy complication	Mainstream schools (frequency)	Schools for children with special needs (frequency)	P value
Number of subjects with breech presentation	1 (3.23%) n=31	2 (13.33%) n=15	0.244
Number of subjects with other complications during pregnancy	4(9.38%) n=32	4(26.67%) n=15	0.188
Number of subjects with birth complications	5(15.63%) n=32	6(40.00%) n=15	0.136

In the study there were 3 subjects who were a breech presentation at birth. One subject from the MSS and two subjects from the SCSN with no significant difference recorded.

In Table 4.2, no statistically significant scores were shown when comparing the number of subjects with complications during pregnancy and the number of subjects with complications during the birthing process.

4.3.3 Gestational age, birth weight and APGAR scores

Table 4.3: Difference in gestational age, birth weight and APGAR scores between the school groups

Perinatal factors	Mainstream schools (mean values)	Standard deviation	Schools for children with special needs (mean values)	Standard deviation	P Value
Gestational age (weeks)	37.61 n=31	+/-2.53	38.53 n=15	+/-1.77	0.295
Birth weight (kilograms)	2.88 kg n=30	+/-053	3.19 kg n=15	+/-0.56	0.084
APGAR 1 (score/10)	8.75 n=24	+/-094	8.71 n=14	+/-0.61	0.900
APGAR 2 (score/10)	9.70 n=23	+/-0.70	9.54 n=13	+/-0.52	0.487

The above Table 4.3 indicates that no difference in the perinatal factors between the research groups.

4.3.4 Previous and current medical history

Table 4.4: Difference in previous and current medical history between the school groups

Previous and current medical history	Mainstream school (frequency)	Schools for children with special needs (frequency)	P Value
Previous hospitalizations (percentage)	11(34.38%) n=32	10(66.67%) n=15	0.059
Previously convalescing from illness (percentage)	1(3.13%) n=32	2(13.33%) n=15	0.235
Orthopaedic abnormalities(percentage)	1(3.23%) n=31	2(14.29%) n=14	0.224
Previously been unconscious(percentage)	4(12.50%) n=32	2(14.29%) n=14	1.000
Previously had a serious fall (percentage)	7(21.88%) n=32	2(13.33%) n=15	0.679
Under care of paediatrician (percentage)	1(3.13%) n=32	7(46.67%) n=15	0.001*
Currently taking medication (percentage)	4(12.90%) n=31	12(80.00%) n=15	0.000*
Hearing or visual problems (percentage)	5(15.63%) n=32	4(26.67%) n=15	0.438

The above table compares the previous and current health of the MSS and SCSN groups. There was no significant difference when comparing orthopaedic abnormalities, hearing or visual problems and whether the child had previously had a serious fall or had been previously unconscious. As highlighted there was a significant statistical difference, with participants from the SCSN group currently taking more medication and are under the care of a paediatrician.

4.3.5 Attendance of therapy

Table 4.5: Difference in attendance of therapy between the school groups

Type of therapy	Mainstream school (frequency) n = 32	Schools for children with special needs (frequency) n = 15	P Value
Occupational therapy	8(25.00%)	15(100.00%)	0.000***
Speech therapy	2(6.25%)	15(100.00%)	0.000***
Physiotherapy	2(6.25%)	7(46.67%)	0.002***

The p-value for all three therapies indicates a significant difference in the number of children who attend all three therapies between the two groups, with 100% of participants in the SCSN groups attending both Occupational Therapy and Speech Therapy.

4.3.6 Beery Visual Motor Integration scores

Table 4.6: Beery Visual Motor Integration test in different school groups

	Mainstream schools (mean values)	Standard Deviation	Schools for children with special needs (mean values)	Standard Deviation	P Value
Beery Visual Motor Integration (z-score)	0.197 (n=32)	0.76	-0.731 (n=15)	0.58	0.000***
Beery Visual Motor Integration-Visual Perceptual component (z-score)	0.782 (n=32)	1.03	-0.615 (n=15)	1.17	0.000***
Beery Visual Motor Integration-Motor Component (z-score)	-0.030 (n=32)	0.67	-1.001 (n=15)	0.81	0.000***

The Two Sample T-Test was used to determine if the means between the MSS and the SCSN groups were equal. As shown in the table, there was a

statistically significant variation in the scores between the Beery VMI, Beery VMI Perceptual and the Beery VMI Motor Components between the mainstream school and for the SCSN.

4.4 Differences in perinatal factors between participants for different modes of delivery

4.4.1 Pregnancy complications

Table 4.7: Difference in pregnancy complications between the normal vaginal delivery and elective caesarean section groups

Pregnancy complication	Normal vaginal delivery (frequency) n=12	Elective caesarean (frequency) n=21	P value
Number of subjects with breech presentation	0	2 (9.52%)	0.52
Number of subjects with other complications during pregnancy	0	3 (14.29%)	0.18
Number of subjects with birth complications	2 (16.67%)	3 (14.29%)	0.86

As can be seen in Table 4.7 there were no NVD breech deliveries. Only two mothers reported birthing complications with children born via NVD. There were no significant differences between the NVD and ELCS groups in terms of breech presentation, and birth and pregnancy complications.

Table 4.8: Difference in pregnancy complications between the normal vaginal delivery and emergency caesarean section groups

Pregnancy complication	Normal vaginal delivery (frequency) n=12	Emergency caesarean (frequency) n=12	P value
Number of subjects with breech presentation	0	1 (8.33%)	0.31
Number of subjects with other complications during pregnancy	0	4 (33.33%)	0.028*
Number of subjects with birth complications	2 (16.67%)	6 (50%)	0.09

Results regarding maternal health during pregnancy indicated that the health of the participants' mothers during their pregnancy in the EMCS is significantly lower compared to the sample of children born by NVD, as seen by the significant p-value for number of subjects with other complications during pregnancy.

Table 4.9: Difference in pregnancy complications between the elective caesarean section and emergency caesarean section groups

Pregnancy complication	Elective caesarean (frequency) n=21	Emergency caesarean (frequency) n=12	P value
Number of subjects with breech presentation	2 (9.52%)	1 (8.33%)	0.23
Number of subjects with other complications during pregnancy	3 (14.29%)	4 (33.33%)	0.34
Number of subjects with birth complications	3 (14.29%)	6 (50%)	0.07

The table above shows the number of subjects born by breech presentation were two children in the ELCS group and one in the EMCS. Four mothers reported on their health difficulties during pregnancy in the EMCS group and three in the ELCS group. The results for birthing complications in the EMCS and in the ELCS groups were six children and three children respectively. Thus no statistically significant variations were found between the birthing complications of the three groups.

4.4.2 Gestational age, birth weight and APGAR scores

Table 4.10: Difference in gestational age, birth weight and APGAR scores between elective caesarean section and emergency caesarean section groups

Perinatal factors	Elective caesarean section (mean values)	Standard deviation	Emergency caesarean section (mean values)	Standard deviation	P Value
Gestational age (weeks)	38.05 n=21	+/-1.16	36.25 n=11	+/-3.60	0.022*
Birth weight (kilograms)	3.18kg n=20	+/-0.44	2.63kg n=12	+/-0.71	0.001***
APGAR 1 (score/10)	8.89 n=17	+/-0.58	8.56 n=9	+/-0.53	0.230
APGAR 2 (score/10)	9.75 n=16	+/-0.45	9.50 n=9	+/-.053	0.530

The above table indicates that there was a statistically significant difference in the p-values for both the gestational age and birth weight. The mean gestational age for the ELCS was 38 weeks and the mean gestational age for the EMCS was 36 weeks. There was a difference of 0.71kg less in the birth weight of the EMCS as compared to the ELCS. There were no statistically significant variations in the APGAR 1 and APGAR 2 scored when comparing the EMCS and the ELCS.

Table 4.11: Difference in gestational age, birth weight and APGAR scores between normal vaginal delivery and elective caesarean section groups

Perinatal factors	Normal vaginal delivery (mean values)	Standard deviation	Elective caesarean section (mean values)	Standard Deviation	P Value
Gestational age (weeks)	39.23 n=12	+/-1.24	38.05 n=21	+/-1.16	0.044*
Birth weight(kilograms)	3.05kg n=11	+/-0.36	3.18kg n=20	+/-0.44	0.402
APGAR 1 (score/10)	8.64 n=10	+/-1.29	8.89 n=17	+/-0.58	0.545
APGAR 2 (score/10)	9.60 n=9	+/-0.97	9.75 n=16	+/-0.45	0.661

The above Table 4.11 indicates a statistically significant difference in the mean gestational age when comparing NVD and ELSC. The average age for ELSC was 38 weeks and for NVD at 39 weeks.

Table 4.12: Difference in gestational age, birth weight and APGAR scores between vaginal delivery and emergency caesarean section groups

Perinatal factors	Normal vaginal delivery (mean values)	Standard deviation	Emergency caesarean section (mean values)	Standard deviation	P Value
Gestational age (weeks)	39.23 n=12	+/-1.24	36.25 n=11	+/-3.60	0.014*
Birth weight (kilogram)	3.05kg n=11	+/-0.36	2.63kg n=12	+/-0.71	0.014*
APGAR 1 (score/10)	8.6 n=10	+/-1.29	8.56 n=9	+/-0.53	0.927
APGAR 2 (score/10)	9.60 n=9	+/-0.97	9.50 n=9	+/-.053	1.000

There is evidence in the table above showing a significant p-value for the mean gestational age and birth weight between the two groups.

4.4.3 Previous and current medical history

Table 4.13: Differences in previous and current medical history between the elective caesarean section and emergency caesarean section groups

Medical history	Elective caesarean section (frequency)	Emergency caesarean section (frequency)	P Value
Previous hospitalizations (percentage)	7(31.82%) n=22	7(58.33%) n=12	0.172
Previously convalescing from illness (percentage)	2(9.09%) n=22	1(8.33%) n=12	0.912
Orthopaedic abnormalities (percentage)	2(10.00%) n=20	1(9.09%) n=11	0.644
Previously been unconscious (percentage)	3(13.64%) n=22	0(0.00%) n=11	0.200
Previously had a serious fall (percentage)	4(18/18%) n=22	2(16.67%) n=12	0.404
Under care of paediatrician (percentage)	4(18.18%) n=22	4(33.33%) n=12	0.421
Currently taking medication (percentage)	8(36.36%) n=22	6(50.00%) n=12	0.423
Hearing or visual problems (percentage)	3(13.64%) n=22	2(16.67%) n=12	0.926

In the above table, the comparison of the medical history between the ELCS and EMCS participants illustrated no statistically significant differences as none of the p-values showed statistically significant differences.

Table 4.14: Differences in previous and current medical history between the normal vaginal delivery and elective caesarean section groups

Medical history	Normal Vaginal Delivery (Frequency)	Elective caesarean section (frequency)	P Value
Previous hospitalizations (percentage)	7(53.85%) n=13	7(31.82%) n=22	0.362
Previously convalescing from illness (percentage)	0(0.00%) n=13	2(9.09%) n=22	0.284
Orthopaedic abnormalities (percentage)	0(0.00%) n=13	2(10.00%) n=20	0.644
Previously been unconscious (percentage)	3(23.08%) n=13	3(13.64%) n=22	0.860
Previously had a serious fall (percentage)	3(23.08%) n=13	4(18.18%) n=22	0.699
Under care of paediatrician (percentage)	0(0.00%) n=13	4(18.18%) n=22	0.114
Currently taking medication (percentage)	2(16.67%) n=12	8(36.36%) n=22	0.736
Hearing or visual problems (percentage)	4(30.77%) n=13	3(13.64%) n=22	0.209

As illustrated in the above table, there is no statistically significant difference in the previous and current medical history between the two groups.

Table 4.15: Differences in previous and current medical history between the normal vaginal delivery and emergency caesarean section groups

Medical history	Normal Vaginal Delivery (Frequency)	Emergency caesarean section (frequency)	P Value
Previous hospitalizations (percentage)	7(53.85%)n=13	7(58.33%)n=12	0.698
Previously convalescing from illness (percentage)	0(0.00%)n=13	1(8.33%)n=12	0.328
Orthopaedic abnormalities (percentage)	0(0.00%)n=13	1(9.09%)n=11	1.000
Previously been unconscious (percentage)	3(23.08%)n=13	0(0.00%)n=11	0.171
Previously had a serious fall (percentage)	3(23.08%)n=13	2(16.67%)n=12	0.294
Under care of paediatrician (percentage)	0(0.00%)n=13	4(33.33%)n=12	0.028*
Currently taking medication (percentage)	2(16.67%)n=12	6(50.00%)n=12	0.285
Hearing or visual problems (percentage)	4(30.77%)n=13	2(16.67%)n=12	0.378

As illustrated in this table, there are more participants born via an EMCS who are currently under the care of a paediatrician, indicating a significant statistical difference. No other statistically significant differences were shown in the health of the NVD and the EMCS subjects.

4.4.4 Attendance of therapy

Table 4.16: Difference in attendance of therapy between the different modes of delivery

Type of therapy	Normal vaginal delivery (frequency)	Elective caesarean section (frequency)	Emergency caesarean section (frequency)	P Value
Occupational therapy	6(46.15%) n=13	11(50.00%) n=22	6(50.00%) n=12	0.106
Speech therapy	3(23.08%) n=13	9(40.91%) n=22	5(41.67%) n=12	
Physiotherapy	3(23.08%) n=13	3(13.64%) n=22	3(25.00%) n=12	

A t-test in the above table was used to determine the variation in the attendance of occupational therapy, speech therapy and physiotherapy between the NVD, ELCS and EMCS subjects. No statistically significant variance was found.

4.4.5 Beery Visual Motor Integration scores

Table 4.17: Beery Visual Motor Integration test scores of the elective caesarean section and emergency caesarean section groups

	Elective caesarean section (mean value) (n=22)	**Standard Deviation**	**Emergency caesarean section (mean value) (n=12)**	**Standard Deviation**	**P Value**
Beery Visual Motor Integration (z-score)	0.02	+/-0.80	-0.06	+/-0.82	0.777
Beery Visual Motor Integration- Visual Perceptual component (z-score)	0.48	+/-1.23	0.73	+/-0.95	0.539
Beery Visual Motor Integration- Motor Component (z-score)	-0.36	+/-0.64	-0.27	+/-0.81	0.737

This table illustrates no statistically significant difference between the three subtests of the VMI when comparing EMCS and ELCS.

Table 4.18: Beery Visual Motor Integration test scores of the normal vaginal delivery and elective caesarean section groups

	Normal vaginal delivery (mean value) (n=13)	**Standard Deviation**	**Elective caesarean section (mean value) (n=22)**	**Standard Deviation**	**P Value**
Beery Visual Motor Integration (z-score)	-0.33	+/-.088	0.02	+/-0.80	0.238
Beery Visual Motor Integration-Visual Perceptual component (z-score)	-0.27	+/-1.40	0.48	+/-1.23	0.107
Beery Visual Motor Integration-Motor Component (z-score)	-0.38	+/-1.18	-0.36	+/-0.64	0.940

This table indicates no statistical significance in the Beery VMI scores between these two groups. The Beery VMI perceptual score for the ELCS group was clinically higher than the NVD group.

Table 4.19: Beery Visual Motor Integration test scores of the normal vaginal delivery and emergency caesarean section groups

	Normal vaginal delivery (mean value) (n=13)	**Standard Deviation**	**Emergency caesarean section (mean value) (n=12)**	**Standard Deviation**	**P Value**
Beery Visual Motor Integration (z-score)	-0.33	+/-.088	-0.06	+/-0.82	0.444
Beery Visual Motor Integration-Visual Perceptual component (z-score)	-0.27	+/-1.40	0.73	+/-0.95	0.049*
Beery Visual Motor Integration-Motor Component (z-score)	-0.38	+/-1.18	-0.27	+/-0.81	0.792

Of significance in the table above are the scores of the Beery VMI Visual Perceptual scores when compared between the two groups. The children born via a NVD scored significantly lower than children born via the EMCS group.

4.5 Summary of results

Demographics of the total sample show that 72.34% of the participants were born by caesarean section, whereas only 27.66% were born by normal vaginal delivery. The gestational age range of the total sample was from 28-41 weeks, with 65% of the total sample born between 37 weeks to 40 weeks. Graphs of the weight at birth of the total sample indicate a range of 1,3kg to 3,9kg. Of the total sample 51% weighed between 2,5kg and 3,4kg.

The distribution of the mode of delivery, namely normal vaginal delivery, ELCS and EMCS showed no statistically significant difference between the MSS and the SCSN groups.

The demographics between the MSS and SCSN groups highlighted that the participants from the SCSN had a higher rate of being treated by a paediatrician and thus taking more medication and more participants attended Occupational Therapy, Speech Therapy and Physiotherapy.

The results indicate that there is statistically a significant difference in the Beery VMI scores between the MSS and the SCSN.

The demographics between the ELCS and EMCS and the NVD and EMCS groups were mostly consistent for the three modes of delivery; however there was a significant difference in the mean gestational age between the three groups. There was also a significant difference in the weight between the ELCS and EMCS and the NVD and EMCS groups. The EMCS groups had a significantly lower birth weight.

When comparing the maternal health and being under the care of a paediatrician, the p-value for the EMCS was significantly lower than for the NVD group.

The Beery VMI scores between the three modes of delivery was the significantly lower score in the Beery VMI perception when comparing the NVD and the EMCS groups, with the children born via a NVD scoring significantly lower. When a comparison was made between the NVD and the ELCS groups a clinical difference was noted in the lower VMI perceptual score of the NVD group.

These highlighted differences will be discussed in detail in the next chapter.

CHAPTER FIVE – DISCUSSION

5.1 Introduction

The following chapter will discuss the results of the study, and the possible reasons for the differences found between the different groups.

The demographic data of the total sample will be discussed in terms of the gestational age, weight at birth and pregnancy complications of all participants. The sample size of the two different schools as well as the sample size from the different modes of delivery will be discussed.

The results of comparing the different birth factors, namely modes of delivery, pregnancy complications, gestational age, birth weight and APGAR scores, medical history and attendance to therapy and Beery VMI scores of the children from the two different schools will be done.

Lastly the comparison between the birth factors, namely: pregnancy complications, gestational age, birth weight and APGAR scores, medical history and attendance to therapy and Beery VMI scores of the children born via different modes of delivery will be discussed.

5.2 Demographic data of total sample

This sample was selected from an affluent portion of the South African population. Due to the influence of poverty on cognitive development, this research focused on children attending private schools in South Africa so that the effects of poverty would not influence the results [53]. As previously reported, research has found that demographic factors play a role in later school outcomes, the northern suburbs of Johannesburg were chosen due to the socio-demographic distribution of the population and therefore exclusion of children born outside of the northern suburbs of Johannesburg was made [55]. Therefore the demographics of this sample may have some significance to the population within the northern suburbs of Johannesburg. However, as the sample size of 47 was smaller than the sample size of 87 calculated by the power calculator, the results of this research should be viewed with caution

and cannot be generalised to the South African population or the population of the northern suburbs of Johannesburg.

Various health conditions in childhood have been associated with learning disorders, as noted in the following references, these were excluded in this research. Human immunodeficiency virus and AIDS in children can be the primary infectious cause for learning disorders amongst other developmental disorders [93]. Certain genetic syndromes are associated with learning disorders [23], for example Fragile X syndrome [94] and Williams syndrome [95]. Other diseases like Klinefelter's syndrome and Turner's syndrome are endocrine syndromes that are co-presented with learning disorders [91, 96]. There have also been numerous studies investigating the impact of diseases of the immune system and learning difficulties [97, 98]. Certain treatments for childhood cancer, including cranial radiation and certain chemotherapy are known to cause learning difficulties [99]. Learning difficulties have been found to be more prevalent in children with epilepsy. Epilepsy can cause the deterioration in brain function and can cause learning disorders [100].
Therefore the sample was carefully selected and children with the above conditions were excluded, to ensure that there are no other medical causes for poor performance in the test administered in the study.

5.2.1 Gestational age

In Figure 4.1, the distribution of the total sample of gestation at birth agrees with the normal variation of distribution for a typical population group, with the gestation of birth ranging from 28 weeks to 41 weeks, with 13 (28%) being born at 39 weeks and 10 (19%) of the total sample being born prematurely. For the purposes of this research, ELGA refers to infants born before 28 weeks and VLGA refers to infants born between 29 and 32 weeks [59]. Late-preterm infants, also referred to as near term, are defined by birth at thirty four weeks and nought days through to thirty six weeks and six days gestation, with some perimeters of late preterm been defined as between 33-37 weeks [60, 61]. Infants are considered to be term, when they are born from 37 weeks

to 41 weeks [62].From the sample being born prematurely in this research, 1(2%) was born ELGA and 8 (17%) were born late-preterm, thus more than 80% of the infants born preterm were born late-preterm.

The WHO recorded rate of preterm birth is from 10% to 18% [72]. The total infants born prematurely (19%) in this research are just above than the WHO frequency, which could be related to the number of children in this study born via caesarean sections, and they are typically done pre-term, which is not consistent with literature.

A study performed in the USA, found that preterm births rose by 20% between 1990 and 2007, with 84% of preterm birth being between 32-36 weeks [52]. Infants born late preterm are a high proportion of children born preterm [73]. This is congruent with the current research where more than 80% of the children born prematurely were born between 32-36 weeks. Moreover, this research indicates the increase in children born prematurely.

Research reviewed found that the gestational period had a strong relationship with special educational needs, with the severity of the educational problems relating to the degree of prematurity [8]. The vulnerability of the late preterm brain is evident from the fact that the last six to eight weeks of pregnancy is responsible for nearly a 35% increase in brain size of the foetus. There is a five-times growth in white matter, structural maturation with increased neuronal connectivity, dendritic arborisation, synaptic junction formation and maturation of neuro-chemical and neuro-enzymatic processes. This leads to questions as to whether infants born early are at risk for permanent neurological injury [79].

Thus children with and without learning difficulties born in the South African private health sector may be exposed to the risk of prematurity, possibly due to the increase of ELCS deliveries. Timing of elective caesarean should therefore be carefully considered as there is still a massive amount of neurological development occurring until full term.

5.2.2 Weight at birth

A review of the birth weight of the total sample in Figure 4.2 in this research found that 34 (85%) of the total sample weighed between 2,7kg and 4.6kg; 3 (7%) of the total sample weighed between 2.5kg and 2.7kg; 7 (13%) participants were below 2.5kg and 1(2%) participant was below 1,5kg.

Statistics from the WHO regarding child growth standards in developed countries, have recorded the average weight for infants at birth at 3,4kg, with a range of 2,7kg to 4,6kg [72], which is consistent with the results of this research. As this research sample has access to private health care and resides in an affluent area of SA, this sample's had similar results with the WHO's recorded average range in developed countries.

This research indicates consistent results in the range gestational weight in this sample as compared to the WHO statistics. With 8 out of 47 in the current research sample weighing between 1.3kg and 2.5kg, indicating that 17% of sample of this research could be at risk for learning difficulties. There are numerous studies that have found a correlation between children with VLBW (less than 1500g) and poor neuro-cognitive functioning including low IQ, specific learning deficits and psychiatric disorders like ADHD [39, 44, 80]. However few studies have examined LBW (less than 2500g) and learning difficulties [80]. One study which examined 10 neuropsychological tests (including spatial, language, fine motor, tactile and attention skills in the WISC-R on six year olds, found that children with LBW scored significantly below children with normal birth weight in these tests [81]. Another study of six-year old children had similar results. Results indicated that LBW was linked to an increase in neurological soft signs, subnormal IQ and learning disorders. This study also found an association between the increase in neurological soft signs in children born with LBW and anxiety, depression and aggressive and delinquent behaviours [39].

As weight at birth have been shown to impact later learning difficulties; careful consideration with regards to the timing of caesarean sections with regards to the impact on weight and gestational age is important.

5.2.3 Pregnancy complications

Of the 17.02% that indicated not having normal pregnancies in Figure 4.3, three from the MSS group reported irregular pregnancies and five from the SCSN reported irregular pregnancies. Out of the three mothers of the subjects from the mainstream group experiencing abnormal pregnancies, two subjects were twins. As twin pregnancies do not fall under the category of abnormal pregnancies, only one from the mainstream group experienced an abnormal pregnancy.

Literature contends that 5.8% of pregnant woman experience pre-eclampsia [66], 20%-30% of all pregnancies experience vaginal bleeding [67] and perinatal infections can increase the occurrence of early labour [68]. Thus in the total sample the frequency of birth complications were low, particularly in comparison to the occurrence of vaginal bleeding, which is agreement with the literature. Thus in this research the influence of complications of pregnancy on the total sample is less of an influence than cited in current literature.

5.2.4 Sample size from two school groups

The researcher included participants from both the MSS and SCSN, as seen in figure 4.4, as this ensured that children with and without learning difficulties were included in the sample. By comparing the children from the two schooling systems, results from the test can be compared and differences between the children with and without learning difficulties can be made.

In this study a total of 47 children, 68% (n=32) were recruited from the MSS and 31.91% (n=15) were recruited from the SCNS. At the start of the research the researcher endeavoured to recruit an equal number in both groups; however there were challenges in the recruitment and data collection process, as discussed in the methodology chapter.

5.2.5 Sample size from different modes of delivery

As seen in Figure 4.5, 72% of the total sample was born via caesarean section. Of the subjects born via caesarean section, 46.81% were born via ELCS and only 27.66% were born via a normal vaginal delivery.

The results of this research are congruent with the findings of previous research, where the birth of infants in the private hospitals in South Africa has a caesarean section rate of 70%, approximately 50% of which are ELCS. This rate is five times more than the WHO recommended rate, and is nearly three times more than that in the public sector hospitals [17, 18].

Information from this and previous literature indicates a high prevalence of ELCS in the private health care system of South Africa.

5.3 Differences in perinatal factors between participants in different school groups

5.3.1 Modes of delivery

Table 4.1 shows no significant difference between the MSS and SCSN groups and the mode of delivery.

Although learning disorders have their origins in genetic and environmental risk factors which influence the child reaching developmental milestones related to learning [23], the leading theory on the aetiology of learning difficulties is a multi-faceted one with a strong genetic origin [23, 24]. Thus based on the current literature, the modes of delivery alone cannot have a significant enough effect to cause learning difficulties.

Literature has shown that delivering an infant via a normal vaginal delivery, ELCS and an EMCS have been shown to impact the health of the mother and the infant [9, 90]. Other perinatal complications including prolonged labour, breech delivery, the use of forceps, caesarean section, assisted delivery and jaundice have also been identified in children, with coordination and sensory processing problems related to learning disorders and these are implicated as possible aetiological factors with this group [20]. Infants delivered preterm

including via caesarean sections are at risk of neuro-developmental problems [9]. A study in Australia has correlated an increased risk for perinatal mortality following a caesarean birth and moreover there is a risk to subsequent siblings [69]. Another study also showed that siblings to an older child born via caesarean section were more likely to be born low birth weight and to have congenital malformations [69]. Despite the risk factors of caesarean births, this research found no statistical association between mode of delivery and later learning difficulties.

The development of learning difficulties cannot be attributed to a single factor and it seems to be multi-faceted. Therefore in this sample it shows that different modes of delivery do not significantly impact the incident of children attending a SCSN. This research supports the evidence that learning difficulties could be multi-faceted. More research is needed in determining the underlying causes of learning difficulties, and it would be useful to compare children in MSS and in SCSN as was done in this study.

5.3.2 Pregnancy complications

In Table 4.2, no statistically significant scores were shown when comparing the subjects with complications during pregnancy and the number of subjects with complications during the birthing process. In the study there were 3 subjects who were born via a breech presentation. One subject from the MSS and two subjects from the SCSN with no significant difference recorded.

Of the 17.02% that indicated not having normal pregnancies, four from the mainstream group reported irregular pregnancies and four from the SCSN reported irregular pregnancies. In the MSS sample, the one mother reported to having a traumatic experience at eight and half months (causing meconium); and one mother had a large fibroid (causing restricted movement of the foetus resulting the foetus having torticollis). The four from the SCSN reported difficulties that ranged from having early labour and being bedridden; having severe eclampsia and being treated for hypertension since 30 weeks; having

in vitro fertilization and one mother reported experiencing transient ischemic attacks throughout the first trimester.

The health of mothers during pregnancy has also been found to cause learning difficulties [63]. Of clinical significance is the variation in the severity of the mothers' health difficulties during pregnancy between the MSS and the SCSN subjects.

Evaluation of the responses given regarding the birthing process in the parent questionnaire indicated that difficulties arose in the MSS sample due to having caesarean sections; one explained that an EMCS was necessary due to the foetus's failure to thrive in the womb, one subject had premature labour which was stopped; another suffered from pre-existing diabetes. From the SCSN sample it was noted that one was eight days overdue; one had a breech presentation; one subject reported foetal distress when the water's broke and there was no available theatre for an emergency caesarean section, another mother reported that her baby's heart beat dropped with each birthing contraction and two were EMCS.

Although environmental differences have been noted in the severity of the problems arising during pregnancy (table 4.2) between the MSS and SCSN, there is no statistical variance in the birthing process between the MSS and SCNS groups.

5.3.3 Gestational age, birth weight and APGAR scores

There were no significant statistical differences between the MSS and SCSN groups in terms of modes of delivery, gestational age, birth weight and the two APGAR scores.

As discussed previously, the factors most commonly linked to learning disorders are genetic influences, low birth weight and prematurity. A study which evaluated children born after 32 weeks and the child's school performance as compared with children born at term, found that birth weight and gestational age were associated with later learning difficulties [14]. Similar research has found that infants born between 32 to 36 weeks are at risk of

educational disorders [50-52]. In this research only one subject (2%) was born before 32 weeks and eight subjects (17%) were born between 32 weeks and 37 weeks. However, in this research, there is no statistically significance variance in the birth weight and gestational age between the MSS and SCSN groups. These results in the current study indicate that the low birth weight and gestational age had little impact on the development of learning difficulties.

With all these risk factors, there are no significant perinatal factors that could have been the cause of the children in this sample to have learning difficulties, thus the results indicate no differences in the perinatal factors between children aged five to seven years in MSS and SCSN.

5.3.4 Previous and current medical history

Factors of significance in Table 4.4 were evident when comparing whether the child was currently under the care of a paediatrician and currently taking medication.

Another factor to note was the number of previous hospitalizations between the two groups with there being more hospitalizations in the SCSN. Both groups had hospital admissions for bronchitis/pneumonia, tonsillectomies and adenoidectomies, hospitalizations due to serious falls, prematurity and jaundice. The SCSN group additionally reported hospitalizations for magnetic resonance imaging (MRI), for an arteriovenous malformation (AVM), two subjects for strabismus eye surgery, removal of a growth and for an overdose of medication. This result compares favourably to the current literature. In the USA, a nation-wide survey comparing the incidence of medical conditions and health care use to children with learning disorders compared with children without learning disorders, was found to be significantly higher in children with learning difficulties [92]. However results must be viewed with caution as more information would be required into whether the hospitalisations for an AVM, MRI and eye surgery impacted those subjects' ability to learn.

Children who struggle at school are often referred to paediatricians for an assessment. An Australian study of more than 8000 patient, reviewing the

most frequent diagnostic assessments performed by paediatricians, concluded that assessments for ADHD and infant development were most prevalent followed by learning difficulties, with the longest consultation time taken for learning difficulties [105]. As cited in the current literature, the children in this research were more under the care of a paediatrician than the children without learning difficulties.

Comments from the parent background information indicated that the children from the SCNS took medication for ADHD and anxiety, namely Risperdal, Ritalin, Luvox and Cipralex, whereas children from the MSS group took chronic medication for allergies and one child took Beroflam Pump medication. The co-morbidity of mental health problems and learning disorders has been well documented, including performance anxiety, social skills deficits, low self-esteem and decreased motivation [24, 40]. Learning disorders have the following co-morbid conditions: Developmental Coordination Disorders; Attention Deficit Hyperactivity Disorder and Major Depressive Disorders. Also, working memory deficits may underlie learning difficulties [29, 46]. ADHD frequently coincides with learning difficulties [35, 47]. These mentioned co-morbid conditions are treated with medication in conjunction with therapy. This was noted in this research where there was a significant difference between children in the MSS group and the children in the SCSN group with more children in the SCSN group were treated with medication for ADHD and anxiety. Those in the SCSN took more medication and more subjects are under the care of the paediatrician.

Therefore children with learning difficulties that attend a SCSN have a higher risk of medical conditions and health care use. Health care professionals should thus note significant details in the medical history when evaluating children as these factors could be impacting on development of learning difficulties. This is of significance in the importance of a team approach when treating children with learning difficulties.

5.3.5 Attendance of therapy

The p-value in table 4.5 for all three therapies indicates a significant difference in the number of children who attend all three therapies between the two groups, with 100% of participants in the SCSN groups attending both Occupational Therapy and Speech Therapy.

For the remediation of learning difficulties, the speech therapist's role is to treat verbal learning difficulties [101]. Occupational therapist treat learning disorders through graded activities that provide the just right challenge [27, 34] to treat the underlying skills of visual perception, VMI, SI processing, postural control, gross and fine motor control and ADL as a foundation processes for scholastic learning [42].The role of the physiotherapist is to treat the underlying motor co-ordination difficulties relating to learning difficulties [102, 103].

Thus, this current study's results compare with previous research, where speech therapy, occupational therapy and physiotherapy are recommended for children with learning disorders and therefore children at SCSN more frequently utilise these therapies.

5.3.6 Beery Visual Motor Integration scores

As shown in the Table 4.6, there was a statistically significant difference in the scores between the Beery VMI, Beery VMI Perceptual and the Beery VMI Motor Component between the MSS and for the SCSN.

Occupational therapists that specialise in paediatrics frequently assess and treat individuals with learning disorders. Occupational therapy treatment of learning disorders is through graded activities that provide the just right challenge [27, 34] that treats the underlying skills of visual perception, VMI, SI processing, postural control, gross and fine motor control and ADL as a foundation processes for scholastic learning [42]. The assessment and treatment frames of reference used in occupational therapy are based on research by Piaget and Gesell which highlighted that the development of

sensori-motor skills forms the foundation for the later development of perception and cognition [43].

A review of the Beery VMI is a good predictor of future non-verbal scholastic performance has been found to be ideal in the assessment of non-verbal learning difficulties in the scope of occupational therapy [3]. Moreover this test has little cultural bias, has been used extensively in numerous countries for educational, medical and research purposes and is also used extensively by occupational therapists. The Beery VMI displays high-level reliability and measures between .80 and .90 levels of validity which remains consistent in numerous studies. Although the Beery VMI correlates moderately with intelligence tests, it is a test of visual and motor development and as such appears to be more sensitive to these neuropsychological problems [3].

Thus the significant difference in the scores between the MSS and SCSN samples indicates the expected variation between children without non-verbal learning difficulties and children with non-verbal learning difficulties. The results also indicate that the Beery VMI is a reliable tool for all three subtests.

As the Beery VMI is a developmental test and a predictor of non-verbal scholastic functioning, the current studies' results indicate that the subjects from the SCSN require continued occupational therapy, speech therapy and physiotherapy to address the underlying sensori-motor difficulties related to the Beery VMI.

5.4 Differences in perinatal factors between participants for different modes of delivery

5.4.1 Pregnancy complications

When evaluating the complications during pregnancy between the participants' modes of delivery in table 4.8, the results of maternal health during pregnancy indicated that the health of the participants' mothers during their pregnancy in the EMCS is significantly diminished compared to the sample of children born via NVD, with no other significant statistical differences found between the pregnancies of the three groups. There were no statistically significant

differences between the various birthing complications. The results of the number of subjects born by breech presentation were two children in the ELCS group and one in the EMCS. There were no NVD breech deliveries. Three mothers reported on their health difficulties during pregnancy in the EMCS indicated and three in the ELCS group reported on health difficulties during pregnancy. There was one mother who reported health difficulties during pregnancy of the children who were born via NVD.

Literature has shown that the poor health of mothers during pregnancy has also been found to cause learning difficulties and intellectual disability [63, 64]. Perinatal factors such as pregnancy hypertension, ante-partum haemorrhage/ threatened miscarriage, urinary tract infection, asthma, breech presentation, elective-caesarean sections, preterm birth, poor foetal growth and the need for resuscitation at birth have been shown in research to be associated with learning difficulties [64].

The following explanations were given regarding the health of the mothers during pregnancy from the three modes of delivery: one mother from the NVD sample reported being robbed at eight and half months, causing meconium. Out of the three mothers (four subjects) having ELCS one had a large fibroid which restricted the foetus moving, resulting in the foetus being born with torticollis, another had a twin pregnancy and one mother reported experiencing transient ischemic attacks throughout the first trimester. The three mothers from the EMCS reported difficulties that ranged from having early labour and being bedridden; having severe eclampsia and being treated for hypertension since 30 weeks and having in vitro fertilization.

The results for birthing complications in the EMCS and in the ELCS groups were six children and three children consecutively. No mothers reported on the birthing complications with children born via NVD.

Evaluation of the responses regarding the birthing process in the parent questionnaire indicated that difficulties arose in the EMCS sample due to having EMCS; one explained that an EMCS was necessary due to the foetus' failure to thrive in the womb, another suffered from pre-existing diabetes, one

was eight days overdue, one mother expressed foetal distress when her water's broke and that there was at first no available theatre for an EMCS and another mother reported that her baby's heart beat dropped with each birthing contraction. From the ELCS sample it was noted that one subject had premature labour which was stopped and then chose an ELCS; one had a breech presentation. Thus there were significant disparities in relation to the severity of health risks to the foetus in the responses between the EMCS and the ELCS samples. This could relate to the relative lowered gestational age and birth weight between the two groups as late preterm infants have a limited ability to adapt to environmental stressors, presenting with more medical conditions [60, 77].

Thus in this research the participants' mothers health during their pregnancy in the EMCS is significantly diminished compared to the sample of children born via NVD. There were significant disparities in relation to the severity of health risks to the foetus in the responses between the EMCS and the ELCS samples with no difficulties reported in the birthing process of children born via NVD. However, in this research, despite the participants' mothers health during pregnancy being significantly diminished in the EMCS group and the significant disparities in the health risks during the birthing process of the EMCS group, these factors did not influence whether the participants had learning difficulties.

5.4.2 Gestational age, birth weight and APGAR scores

However, as noted in Tables 4.10, 4.11, 4.12, when comparing the modes of delivery, there was statistically significant variance in two perinatal factors; birth weight and gestational age.

There were no statistically significant variations in the APGAR 1 and APGAR 2 scores when comparing the three modes of delivery. As shown in Table 4.10, there is a statistically significant difference in the p-values (p=0.022 and 0.001 repectively) for both the gestational age and birth weight when comparing the ELCS and EMCS and Table 4.11 indicates a statistically significant difference

in the mean gestational age when comparing NVD and ELSC. There is evidence in the Table 4.12 showing a significant difference for the mean gestational age and weight between the NVD and EMCS groups. The mean gestational age for NVD at 39 weeks; for the ELCS was 38 weeks and the mean gestational age for the EMCS was 36 weeks.

In the current research late preterm infants form 19% of the study sample which is just above the WHO statistics of 10-18% [72, 73]. Studies available for children who were born between 32-35 weeks, indicate that these children have an increased risk of lower school performance with a recent study showing that one third of children had some form of a learning difficulty [14]. Similarly a study in the USA, found that there were greater education needs among children born between 32 to 36 weeks preterm and prevalent below-average reading skills up to the end of grade two [14]. Statistics from one study comparing healthy late preterm infants and healthy term infants found that there was a 10% to 13% increased risk of children requiring special education in this cohort of children [73].

The low percentage of children who were born via breech presentation in this research is consistent with other studies which indicate scores of about 3-4% of births [69].

There is evidence in the Table 4.12 showing a small p-value of $p<0.01$ for the mean gestational age and birth weight between the NVD and EMCS groups and there was a difference of 0.71kg less in the birth weight of the EMCS as compared to the ELCS.

Research has found that children with low birth weight were linked with a greater risk of learning difficulties as noted in the WISC [80, 81]. Similar results were found in a study of six-year old children [39]. Thus according to the current research, the statistically significant differences between the mean gestational age of the ELCS and EMCS groups in this research could impact on the development of learning difficulties later in life.

There is a statistically significant difference in the age and weight of the infants born via caesarean sections and normal vaginal delivery, which contends with

current literature that describes the impact of low birth weight and gestational age with later learning difficulties. Medical professionals therefore should account for the timing of the birth, when performing ELCS.

In addition, the significant difference between the health of mothers during pregnancy in the NVD and EMCS groups in the current research and that the literature shows that the health of mothers can contribute to the development of learning difficulties, leads to the question as to how the health of mothers during pregnancy has impacted the development of learning difficulties in this research.

Moreover, since literature shows that prematurity and low birth weight of perinatal factors are linked to learning difficulties, these two factors are important to note as well as the mode of delivery when health professionals evaluate children.

5.4.3 Previous and current medical history

In the Table 4.13, the comparison of the medical history between the ELCS and EMCS participants illustrated no statistically significant differences and in Table 4.14, there is also no statistically significant difference in the previous and current medical history between the NVD and the ELCS group.

As illustrated in this Table 4.15, there are more participants born via an EMCS who are currently under the care of a paediatrician, indicating a significant statistical difference. No other statistically significant differences, including the use of medication, were shown in the health of the NVD and the EMCS subjects.

Out of the children born via EMCS taking medication, two were receiving medication for respiratory reasons and four were receiving medication related to concentration/anxiety co-morbidities. This research indicates that children born via an EMCS are more at risk of requiring health services than children born term. Research has also found that the degree of prematurity influences the risk for ADHD proportionally [52]. Moreover, the rate of infants who are born late preterm suffering from one medical condition is four fold and in

addition these infants have three and a half fold risk of having two or more conditions diagnosed [60, 77].

In this research there is a statistically significant difference in the children under the care of a paediatrician and infants born via an EMCS as compared with those born via a NVD, which contends with current literature, that low gestational age impacts the risk of health conditions. Therefore the care and health of pregnant woman by medical professionals is important in preventing EMCS [67, 68].

5.4.4 Attendance of therapy

Table 4.16 showed the difference in the attendance of occupational therapy, speech therapy and physiotherapy between the NVD, ELCS and EMCS subjects. No statistically significant variance was found indicating that mode of delivery has little impact on the attendance in therapy.

5.4.5 Beery Visual Motor Integration scores

As illustrated in Tables 4.17 and 4.18, no statistically significant difference between the three subtests of the VMI when comparing EMCS and ELCS and the ELCS and NVD subjects. As the results of the Beery VMI yielded a highly statistically significant difference ($p=0.000$) between the MSS and SCSN subjects, the validity and reliability of the scores for the EMCS and ELCS groups indicate no significant statistical differences. These results indicate that mode of delivery has little influence over the development of non-verbal learning difficulties.

Of significance is the Beery VMI perceptual score for the ELCS group being clinically higher than the NVD group. Moreover, in the Table 4.19 the p-value score of the Beery VMI Visual Perceptual score indicated that the children born via a NVD scored significantly lower than children born via the EMCS group. This could be due to the influence of genetic predisposition and environmental stimulation following birth [23]; however, in the results of this

research it is not clear as to what is the reason for this discrepancy in these two scores.

Although there were significant differences in the various perinatal factors which have previously been linked to learning difficulties, there was no significant variation in the Beery VMI subtest scores for the three modes of delivery. These perinatal factors included: lowered birth weight and gestational age in the ELCS and EMCS groups and the high percentage of caesarean sections in the sample versus normal vaginal delivery. As the sample is from private schools, the good environmental stimulation could account for development of these skills [23]. Also of significance is the genetic influence on learning difficulties [23, 24].

5.5 Limitations of study

The most significant limitation in the current research is the small sample size of the SCSN. Reasons for the small sample size in the SCSN group included principals not giving permission, parents' not giving consent for their children to participate in the research and parents not emailing back the electronic parent questionnaire. The small sample size impacted the ability to accurately apply the multi-point testing of the perinatal factors so as to assess the association of these factors with learning difficulties. In addition, studies with large sample sizes render more statistically accurate data. Despite this limitation, the sample size was adequate in assessing the difference in the Beery VMI scores, with the findings indicating a significant statistical difference between the MSS and SCSN.

Another limitation of the study was that the parents' did not complete all aspects of the electronic parent questionnaire. This further impacted the sample size of specific demographic information.

Each participant completed the test according to the instruction manual, with the researcher not being blinded as to whether the child had learning difficulties or not.

5.6 Summary of discussion

The discussion reviewed the demographics of the total sample, compared the results between the MSS and SCSN subjects and compared the results between the three modes of delivery.

The comparison between the demographics and perinatal factors, modes of delivery and pregnancy complications of the MSS and SCSN and between the ELCS, EMCS and NVD births highlighted no significant differences between the samples. Of statistical significance however; were the birth weight and gestational age between the EMCS and NVD, ELCS and EMCS births. Those born via EMCS delivery had statistically significant lower birth weight and gestational age.

However there was a statistically significant variation in the Beery VMI scores between the MSS and SCSN subjects. This indicates that the mode of delivery and the perinatal factors (including the maternal health) have little influence on later learning difficulties. This corresponds with the current literature on learning disorders, which largely attributes learning disorders to a genetic predisposition.

Of statistical significance was the difference between the children attending occupational therapy, speech therapy and physiotherapy from the SCSN and MSS groups. In addition, children from the SCSN group also took more medication, relating to the co-morbidity of ADD and there were thus a higher rate of children from the SCSN being under the care of a paediatrician.

When comparing the Beery VMI scores between the three modes of delivery, no statistically significant variation were recorded, except for lowered score for the Beery VMI perceptual of the NVD sample when comparing the NVD and the EMCS samples. These scores indicate that the mode of delivery has little influence on the development of later learning disorders, as the genetic influence and later environmental stimulation appear to correlate more to the development of learning disorders. However these scores should be viewed with caution due to the small sample size.

CHAPTER SIX – CONCLUSION

The aim of the study was to describe the differences in antenatal and perinatal birth factors and Beery VMI scores according to the schools the children attend (thus whether they have learning disorders or not) and their mode of delivery at birth. The children were aged five, six and seven years and were born in the South African private health sector. Children were included in the study if their parents consented and then completed a parent questionnaire. The VMI test was performed on 47 participants, of which 32 were from the MSS and 15 were from the SCSN. This concluding chapter will summarize the main findings according to the objectives of this study.

The total sample fell within the range of the normal population as the weight and gestational ages of all the children fell within the normal range. The modes of delivery for this sample were ELCS (46.81%), EMCS (25.53%) and normal vaginal delivery (27.66%). Of the mothers in this study, 17.02% reported pregnancy complications, which is relatively low compared to research by the WHO.

The following conclusions can be made regarding the two objectives set for this research study:

Objective 1:

To describe the differences in mode of delivery, pregnancy complications, gestational age, birth weight, APGAR scores, medical history, attendance to therapy and Beery VMI scores of children aged five to seven years in MSS and SCSN.

This current study found that there was no statistically significant difference in the mode of delivery between the MS and SCSN groups.

The study showed that the most commonly occuring pregnancy complications were more prevalent in the mothers of the children in the SCSN group, although the difference was not statistically significant.

There were no statistically significant differences between the in terms of gestational age, birth weight and the two APGAR scores.

Three factors that were statistically significantly different between the two groups were that children in the SCSN group were under the care of a paediatrician more often, they were currently taking medication and they were more frequently admitted to hospital. The research found that the SCSN group utilised all three therapies significantly more than the children in the MSS group. Therefore the children with learning difficulties in this sample that attend a SCSN have a higher incidence of medical conditions and health care use. Health care professionals should thus note significant details in the medical history when evaluating children as these factors could be impacting on development of learning difficulties.

In this research the three sub-tests were used to determine the Beery VMI skills of children in the two groups. There was a highly significant statistical difference between the two groups in the VMI subtest, the VMI visual perceptual subtest and the VMI motor component subtest.

Therefore, in this research the Beery VMI as a developmental test of VMI shows a relationship between lowered VMI scores and non- verbal scholastic functioning. The current study results indicate that the children from the SCSN group scores in the VMI subtests were significantly lower than that of their peers in MSS. Occupational therapists and other health professionals can therefore use this test, as part of the battery of tests, when determining non-verbal learning difficulties.

Objective 2:

To describe the differences in pregnancy complications, gestational age, birth weight, APGAR scores, medical history, attendance to therapy children and Beery VMI scores of children aged five to seven years who were born via different modes of delivery.

This study showed that there was a statistically significant difference with regards to gestational age and birth weight between the ELCS and the EMCS groups. In this research, children born via EMCS were therefore more frequently born prematurely and with lower birth weight. Since literature shows that prematurity and low birth weight are linked to learning difficulties, these

two factors are important to note as well as the mode of delivery when health professionals evaluate children.

The only statistically significant difference between the NVD and the ELCS groups was the gestational age. This is because elective caesareans are usually performed before the term due date. This was also found in the results of the mean gestational age and birth weight between the NVD and EMCS groups, where an EMCS are as a result of premature labour. Moreover, since literature shows that prematurity and low birth weight of perinatal factors are linked to learning difficulties, these two factors are important to note as well as the mode of delivery when health professionals evaluate children.

The comparison of the medical history between the ELCS and EMCS participants illustrated no statistically significant differences. Furthermore, no other statistically significant differences, including the use of medication, were shown in the health of the NVD and the ELCS subjects. There is a statistical difference in the participants born in the EMCS group who are currently under the care of a paediatrician as compared to the NVD. Literature contends that low gestational age shows an increase in the risk of health conditions. Therefore the care of health of pregnant woman by clinicians is important in preventing emergency caesarean sections, as there could be an effect on the child's health later in life if born prematurely.

No statistically significant difference between the three subtests of the VMI was found when comparing EMCS and ELCS and the ELCS and NVD subjects.

In this study the Beery VMI Visual Perceptual score, when compared between the EMCS and NVD groups, indicated that the children born via a NVD scored significantly lower than children born via the EMCS group. The Beery VMI perceptual score for the ELCS group is also clinically higher than the NVD group. Development is complex and what is evident in this research is that learning difficulties cannot be attributed to a few selected factors. More research is needed in a bigger sample and over a long period of time.

These results indicate that mode of delivery has little influence over the development of non-verbal learning difficulties.

Recommendations for future studies

Literature states that socio-economic status and gender are factors that also influence the development of learning difficulties, but these factors were outside of this study's scope. It is recommended that future studies are conducted to determine the influence of these factors on learning difficulties in the South African population.

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APPENDICES

Appendix A: Ethical clearance

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Mrs Lauren Ferraris

CLEARANCE CERTIFICATE	M120921
PROJECT	Incidence of Perinatal Birth Factors in Children with Learning Disabilites Aged Five Years Born in the South African Private Health Sector
INVESTIGATORS	Mrs Lauren Ferraris.
DEPARTMENT	Department of Occupational Therapy
DATE CONSIDERED	28/09/2012
DECISION OF THE COMMITTEE*	Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

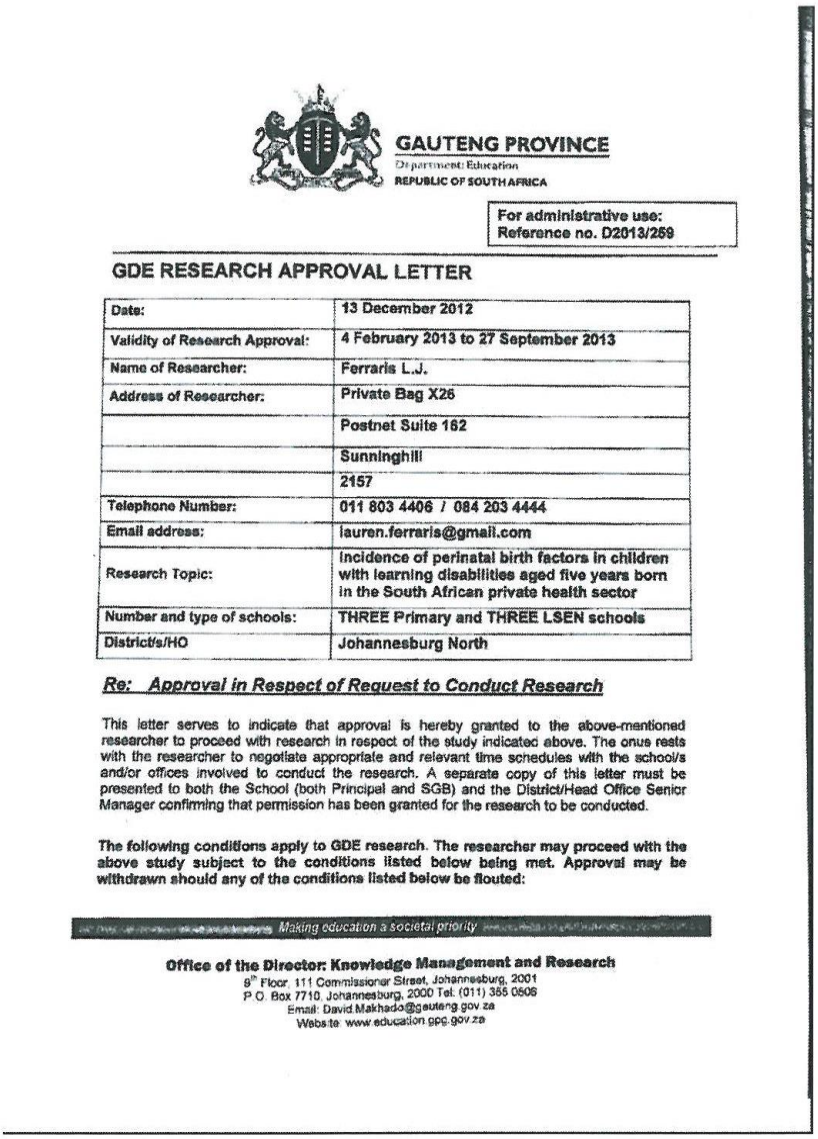
DATE 16/11/2012 CHAIRPERSON .....
(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable
cc: Supervisor : Juliana Freeme

DECLARATION OF INVESTIGATOR(S)
To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. I agree to a completion of a yearly progress report.

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES...

Appendix B: Permission from Gauteng Department of Education



GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

For administrative use:
Reference no. D2013/259

GDE RESEARCH APPROVAL LETTER

Date:	13 December 2012
Validity of Research Approval:	4 February 2013 to 27 September 2013
Name of Researcher:	Ferraris L.J.
Address of Researcher:	Private Bag X26
	Postnet Suite 162
	Sunninghill
	2157
Telephone Number:	011 803 4406 / 084 203 4444
Email address:	lauren.ferraris@gmail.com
Research Topic:	Incidence of perinatal birth factors in children with learning disabilities aged five years born in the South African private health sector
Number and type of schools:	THREE Primary and THREE LSEN schools
District/s/HO	Johannesburg North

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

The following conditions apply to GDE research. The researcher may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

Making education a societal priority

Office of the Director: Knowledge Management and Research
8th Floor, 111 Commissioner Street, Johannesburg, 2001
P.O. Box 7710, Johannesburg, 2000 Tel: (011) 355 0506
Email: David.Makhado@gauteng.gov.za
Website: www.education.gpg.gov.za

Appendix C: Information letters Schools

Occupational Therapy

School of Therapeutic Sciences • Faculty of Health Sciences • 7 York Road, Parktown 2192, South Africa
Tel: +27 11 717-3701 • Fax: +27 11 717-3709 • E-mail: denise.franzsen@wits.ac.za

INFORMATION LETTER: SCHOOLS

Permission to send out a questionnaire regarding birth factors and to administer the Beery-Buktenica Developmental Test of Visual Motor Integration and birth factors with learners for research purposes

The Principal,

…… School,

Dear Mr/Mrs ……..,

My name is Lauren Ferraris. I am currently a registered student for the M.Sc. (O.T) course at the University of the Witwatersrand. The title of my research is the: "Incidence of perinatal birth factors in children with learning disabilities aged five years born in the South African Private Health Sector".

I am a qualified Occupational Therapist and I have been practicing in the field of pediatrics, particularly learning difficulties for the past 12 years, working in private practice in Northern Johannesburg. The purpose of this study is to evaluate the possible risk involved in perinatal birth factors and later learning difficulties in children.

Introduction

Occupational Therapists are becoming increasingly aware of the rise in the number of referrals of children with learning difficulties. The connection between this increase in the rate of learning difficulties and perinatal birth factors has been questioned by various parents and educational providers.

The purpose of the study and procedure

The research will include sending out a parent information and consent form to request permission for children to be included in the research, to all parents of five year old learners from your school. I will only select children born in the private health care sector to be part of the research.

A background questionnaire will be electronically emailed to the parents of the 5 year old learners from your school who give informed consent for their and their child's participation. I will administer the Beery-Buktenica Developmental Test of Visual Motor Integration to these children when their parents have returned a demographic questionnaire. This test, developed in 1984, through research has shown a high correlation in predicting later learning difficulties. The data collected from this test will examine if there is an association between a child's perinatal birth factors and later learning difficulties. The learner's confidentiality will be observed, by not including any of the participant's personal details in the reporting of the research.

Duration of the study

The testing of the subjects will occur in the school mornings, during a time that is appropriate. The testing time will be approximately 45 minutes per child. The testing period should be approximately 2 weeks. All children will be asked to give witnessed verbal assent to be part of the study.

Ethical approval of study

This study protocol has received ethical clearance from the Human Research Ethics Committee of the University of the Witwatersrand.

The rights of the participants in this study

The participants have the right at any time to withdraw from the study, without stating reasons, with their data being removed with there being no adverse effect to the student in any way. If they are receiving any therapy, this therapy will continue as usual.

Confidentiality

Confidentiality will be maintained by ensuring that any of the personal details of the applicants are not reflected in both the verbal and written reporting of this research. Feedback regarding the results will be made available to the parents in the case of low scores and they will be provided with the names of occupational therapists in their area if they wish to follow up the assessment findings.

Contact details

For queries regarding this study please contact the Wits Occupational Therapy Department on 011 717 3701, and for any ethical queries, please contact Prof. Cleaton-Jones, Chairman of the Human Research Ethics Committee at Wits on (011) 717 1234.

Please contact Lauren Ferraris (researcher) for any queries.

Contact details: email: lauren.ferraris@gmail.com

Mobile telephone: 0842034444

Office telephone: 0118034406

Yours Sincerely

Lauren Ferraris

Appendix D: Permission to do research Schools

Permission to do Research: Schools

I hereby give consent for the school where I am currently principal, _____ (name of school) to participate in the research outlined in the letter.

Name: _____

Signature: _____

Date: _____

Appendix E: Information sheet Participants

Occupational Therapy

School of Therapeutic Sciences • Faculty of Health Sciences • 7 York Road, Parktown 2192, South Africa
Tel: +27 11 717-3701 • Fax: +27 11 717-3709 • E-mail: denise.franzsen@wits.ac.za

INFORMATION SHEET: PARENTS

Dear Parent/Legal Guardian,

My name is Lauren Ferraris. I am currently a registered student for the M.Sc. (O.T) course at the University of the Witwatersrand. The title of my research is the: "Incidence of perinatal birth factors in children with learning disabilities aged five years born in the South African Private Health Sector".

I am a qualified occupational therapist and I have been practicing in the field of pediatrics, particularly learning difficulties for the past 12 years, working in private practice in Northern Johannesburg. The purpose of this study is to evaluate the possible risk involved in perinatal birth factors and later learning difficulties in children.

Introduction

Occupational therapists are becoming increasingly aware of the rise in the number of referrals of children with learning difficulties. The connection between this increase in the rate of learning difficulties and perinatal birth factors has been questioned by various parents and educational providers.

The purpose of the study and procedure

I would like to invite you and your child to be part of this study. I am asking you to complete the attached informed consent form if your child was born in a private hospital. If you agree to participate a background questionnaire will be emailed to you for completion. The questionnaire should take you about 10 minutes to complete and this should be emailed back to me.

I am asking permission to administer the Beery-Buktenica Developmental Test of Visual Motor Integration to your child. This test, developed in 1984, through research has shown a high correlation in predicting later learning difficulties. The test takes approximately 45 minutes to administer and your child will have to name some objects, copy some shapes, identify shapes, draw and recite the alphabet.

The testing will occur in the school mornings, during a time that is appropriate and arranged with the teacher.

Ethical approval of study

This study protocol has received ethical clearance from the Human Research Ethics Committee of the University of the Witwatersrand.

The rights of the participants in this study

You and your child have the right at any time to refuse to participate or withdraw from the study, without stating reasons, without any consequences. Your child's therapy if they are receiving therapy will continue as usual.

Confidentiality

Your and your child's confidentiality will be observed, by not including any of the participant's personal details in the reporting of the research or on the data forms.

Feedback regarding the results will be made available to you in the case of low scores found for children that are not already attending therapy, you will be provided with the names of occupational therapists in their area if they wish to follow up the assessment findings.

Contact details

For queries regarding this study please contact the Wits Occupational Therapy Department on 011 717 3701, and for any ethical queries, please contact Prof. Cleaton-Jones, Chairman of the Human Research Ethics Committee at Wits on (011) 717 1234.

Please contact Lauren Ferraris (researcher) for any queries.

Contact details: email: lauren.ferraris@gmail.com

Mobile telephone: 0842034444

Office telephone: 0118034406

Yours Sincerely

Lauren Ferraris

Appendix F: Informed Consent - Parents

I, _____hereby give consent for me and my child _____ to participate in the research outlined in the information sheet.

I understand that participation is voluntary and confidentiality will be maintained, and that we may withdraw from the study at any time.

My name: _____

My telephone number:

_____

My email address:

_____

At which hospital was your child born?

_____

Was this under public or private health care?

_____

Signature: _____

Date: _____

Appendix G: Parent background Questionnaire

Information to be kept separate

Code _____

Parent's Name _____

Child's full name _____

Address

_____

_____

(Street) (City) (Code)

Parent's telephone no_____

Child's birth date _____

Child's Age_____

Grade __

Name of School_____

Teacher's name_____

Code _____

Birth and Health History

At which hospital was your child born? _____

Was this under public or private health care? _____

Normal pregnancy in every respect? Yes/No If no, explain_____

_____

Was your baby a breech presentation? Yes No

Type of birth:

Type of birth	
Natural Vaginal Delivery	
Natural Vaginal Delivery with forceps	
Natural Vaginal Delivery with suction	
Emergency Caesarean Section	
Elective Caesarean Section	

1) Please tick the appropriate box of your child's gestational age

Gestational Age at Birth	Tick appropriate age
28 Weeks	
29 Weeks	
30 Weeks	
31 Weeks	
32 Weeks	
33 Weeks	
34 Weeks	
35 Weeks	
36 Weeks	
37 Weeks	
38 Weeks	
39 Weeks	
40 Weeks	

2) Apgar rating, if known _____
3) Child's height at birth_____ Child's weight at birth _____
4) List if any, other complications from the birth _____

_____

5) Has your child ever been hospitalised? Yes/ No
If yes, explain and give
dates_____
6) Has your child been forced to spend long periods convalescing from illness? Yes/No
If yes, explain_____
7) Has your child ever had an orthopaedic or movement problem (condition of the muscle, joint or bone)?
If yes, explain_____

_____

8) Has your child ever been unconscious? Yes/No
If yes, explain

_____

9) Has your child ever suffered a serious fall? Yes/No
If yes, explain

_____

10) Does your child suffer from any of the following illnesses of:

Illness	**Yes**
HIV	
Genetic Syndrome	
Cancer	
Infectious diseases	
Diseases of the immune system	
Cardiac diseases	
Endocrine diseases	
Epilepsy	

11) If you have ticked yes to an above illness, please clarify:_____

_____

12) Is your child currently under the care of a physician? Yes/No
If yes, explain_____

_____

13) Is your child currently taking medication? Yes/ No
If yes, explain

_____

14) Does your child have a visual or a hearing problem? Yes/ No
If yes, explain

_____

15) Is your child attending Occupational Therapy, Physiotherapy or Speech Therapy?

_____

Thank you for your time

The Beery–Buktenica
Developmental Test of Visual–Motor Integration

Code (for administrator use only):_____

Beery™ VMI Sixth Edition

Ages 2 through 7 (SHORT FORM)

by Keith E. Beery, Norman A. Buktenica, and Natasha A. Beery

Examiner: _____

Test Date: _____ year _____ month _____ day

Birth Date: _____ year _____ month _____ day

Chronological Age: _____ year _____ month

(Count more than 15 days as one month.)

SUMMARY

See the Beery VMI manual (sixth edition) for norms.

	Beery VMI	Visual Perception	Motor Coordination
Raw Scores:	_____	_____	_____
Standard Scores:	_____	_____	_____
Scaled Scores:	_____	_____	_____
Percentiles:	_____	_____	_____
Other Scaling:	_____	_____	_____

Comments and Recommendations:

PROFILE

Standard Score	Beery VMI	Visual Perception	Motor Coordination	Percentile
145	-	-	-	99.7
140	-	-	-	99.2
135	-	-	-	99
130	-	-	-	98
125	-	-	-	95
120	-	-	-	91
115	-	-	-	84
110	-	-	-	75
105	-	-	-	63
100	-	-	-	50
95	-	-	-	37
90	-	-	-	25
85	-	-	-	16
80	-	-	-	9
75	-	-	-	5
70	-	-	-	2
65	-	-	-	1
60	-	-	-	.8
55	-	-	-	.3

Begin testing on page 1. Turn booklet over with bound edge toward the examinee. If subtests are used, always test in this order: VMI → Visual → Motor.

PEARSON

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3 4 5 6 7 8 9 10 11 12 A B C D E

PsychCorp

Product Number 46243/46244

The Beery™ VMI Developmental Test of Visual Perception

Visual Perception

Sixth Edition

by Keith E. and Natasha A. Beery

Ages 2 to 100

TURN

Code (for administrator use only):_____

School: _____ Grade: _____

Examiner: _____

Test Date: _____ year _____ month _____ day

Birth Date: _____ year _____ month _____ day

Chronological Age: _____ year _____ month

(Count more than 15 days as one month.)

Items 1–3 are for children; credit for adult if Item 4 is answered correctly.

Item 1. Points to one body part on self when asked: __ eye __ hair __ ear

Item 2. Points to at least 2 of 3 outline pictures: __ cat __ dog __ pig

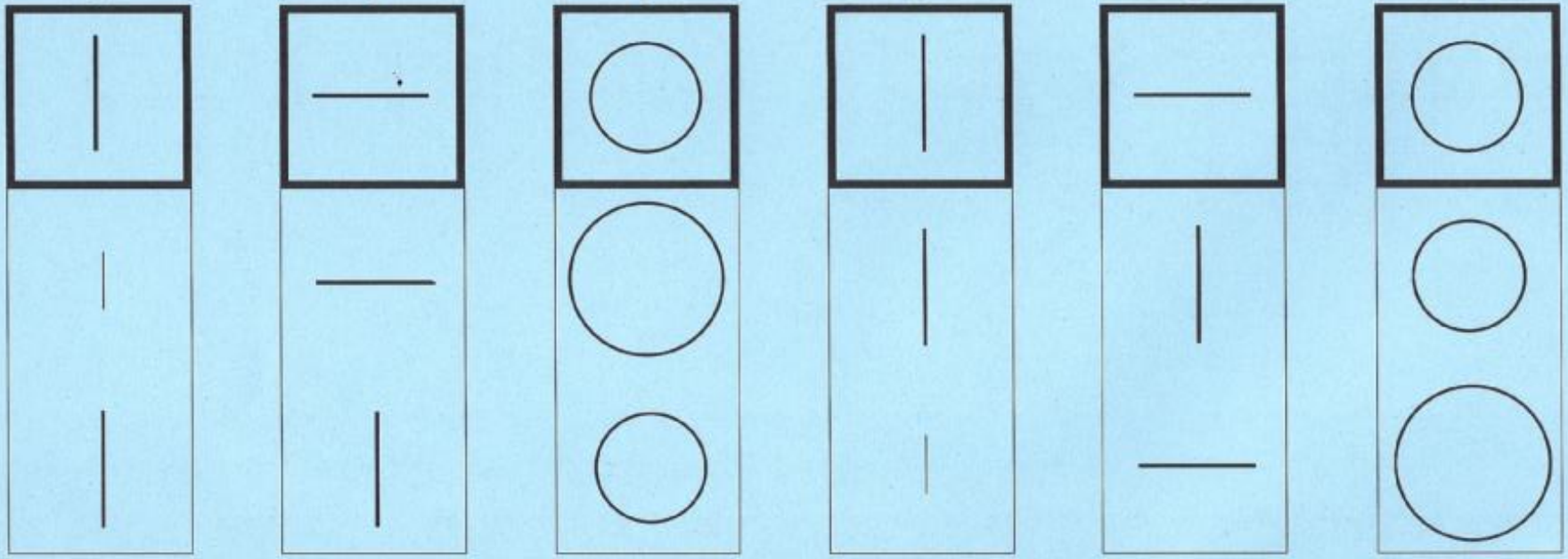
Item 3. Points to 6 of 8 pictured body parts when asked:
__ hair __ nose __ ear __ foot __ mouth __ hand __ tummy __ eye

Visual Perception Raw Score: _____ (Also enter on the front of the Beery VMI test booklet.)

See the Beery VMI manual (sixth edition) for administration and scoring instructions.

Start timing here.

4 5 6 7 8 9



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Product Number 46246/46247

The Beery™ VMI Developmental Test of Motor Coordination

Motor Coordination

Fifth Edition

by Keith E. and Natasha A. Beery

Ages 2 through 18

TURN

Code (for administrator use only):_____

School: _____ Grade: _____

Examiner: _____

Test Date: _____ year _____ month _____ day

Birth Date: _____ year _____ month _____ day

Chronological Age: _____ years _____ months

(Count more than 15 days as one month.)

Motor Coordination Raw Score: _____ (Also enter on the front of the Beery VMI test booklet.)

See the Beery VMI manual (fifth edition) for administration and scoring instructions.



Let's Draw!

Use a No. 2 pencil (or another pencil with soft black lead) or a ballpoint pen with black ink.
Remember, you get one try with no erasing.
Keep the booklet straight in front of you and don't tilt it.
Just do the best you can on both the easy ones and the hard ones.

Don't skip any!

Please turn the page from the top to begin.

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Product Number
46220/46221

Appendix I: Verbal assent - children

Hi.

My name is Lauren,

I am going to ask you some specific questions and I am asking you to draw for me. This is not a test and there is no right or wrong answer. By being in the study, you will help me understand how children's learning is affected.

Your mom/dad says it's okay for you to be in my study, but if you don't want to do this you don't have to be.

Do you have any questions for me now?

Would you like to answer some questions and draw some pictures with me?

NOTES TO RESEARCHER: The child should answer "Yes" or "No." Only a definite "Yes" may be taken as assent to participate.

Name of Child: _____

Parental Permission on File: ☐ Yes ☐ No ***(If "No," do not proceed with assent or research procedures.)***

Child's Voluntary Response to Participation: ☐ Yes ☐ No

Signature of Researcher:_____

Date_____

Witness Signature: _____