THE PREVALENCE OF VISUAL DEFICIENCIES IN CHILDREN WITH LEARNING PROBLEMS IN THE REGION OF JOHANNESBURG

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Supervisor: Prof J.T. Ferreira

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ABSTRACT

The purpose of this study was to determine the prevalence of vision deficiencies in the children from the schools of the learning disabled compared to the children from the mainstream schools. One hundred and twelve (N = 112) children from the two learning disabled schools and eighty (N = 80) children from the mainstream school, in Johannesburg had their vision assessed.

The evaluation of functional vision included visual acuity (Snellen Acuity), refractive status (Static Retinoscopy), ocular health status (Internal and External evaluations), accommodation (Monocular Estimate Method (MEM), ±2.00D Flippers, Donder's push up method), binocularity (Cover Test, Vergence Facility, Smooth Vergences, Near Point of Convergence (NPC) and ocular motilities (Direct Observation).

The results of this study revealed a significant relationship of poor vergence facility (Cramer's V =0.369); lead of accommodation of the right (Cramer's V = 0.379) and left eye (Cramer's V= 0.386); poor amplitude of accommodation of the left eye (Cramer's V=0.316) and the mainstream group. A significant relationship was found between the learning disabled group and poor saccadic accuracy (Cramer's V=0.343) and a high lag of accommodation of the right (Cramer's V= 0.379) and the left eye (Cramer's V= 0.386). Both the learner groups in the current study present with different visual deficiencies, and thus comparisons in terms of prevalence is complicated. It will be erroneous to say one group presents with a high prevalence of visual deficiencies than the other nor to conclude that the prevalence of visual deficiencies is the same in both groups.

The results of this study provide further support for full vision screenings (including visual integrity pathway, and visual efficiency skills) to be routinely done in both mainstream and schools for the learning disabled.

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CHAPTER 1

ORIENTATION TO THE STUDY

1.1 INTRODUCTION

The prevalence of visual deficiencies in children with learning problems has been a subject of interest for many decades. Numerous studies (Hoffman, 1980; O' Grady, 1984; Grisham and Simons, 1986; Rosner & Rosner, 1987; Simons & Gassler, 1988; Woodhouse, Adler & Dulgan, 2003; Goldstand, Koslowe, Parush, 2005) pointed out that visual deficiencies are found more often in children with learning disabilities. Blika (1982), Helveston, Weber, Miller, Robertson, Hohberger, Estes, Ellis, Pick and Helveston (1985); Goulandris, McIntyre, Snowling, Bethel and Lee (1998), Kedzia, Tondel, Pieczyrak and Maples (1999) to the contrary found the prevalence of visual deficiencies to be the same in children with and without learning disabilities. Despite the different findings from various studies there is still controversy regarding the role that vision plays in learning to read or reading to learn (Committee on Children with Disabilities, American Academy of Paediatrics (AAP) and American Academy of Ophthalmology and Strabismus (AAPOS), 1998; Poytner, Schor, Haynes & Hirsh, 1982; Evans, Drasdo & Richards, 1994; Kiely, Crewther & Crewther, 2001). Thus it is essential to determine the prevalence of visual deficiencies in children labelled as having learning disabilities compared to children from the mainstream school.

In South Africa there is a serious lack of reliable information regarding the accurate statistics on the prevalence of learning disabilities as mentioned in detail in chapter 2. The data from the South African, Education Management Information System (EMIS) (2001) referred to in the White Paper 6(2001) indicated that 20% of children with learning disabilities were accommodated in the educational system. It was thus projected that of approximately 293,000 – 346,000 learning disabled children, only about 64,200 learners were accounted for. In the White Paper 6 (2001) it was further stated that learning disabilities were attributed to various factors including psychological, neurological, language difficulties or speech problems, hearing, visual deficiencies and disadvantaged backgrounds. A census data by (EMIS) in the White paper (6) 2001 indicated the prevalence of visual disabilities without categorising them in terms of low vision or visual efficiency disorders, as being more prevalent (41.05%) than any other disorder contributing to learning disabilities.

From the above mentioned studies contradictory conclusions have thus emerged, in which some studies have concluded that visual deficiencies are more prevalent in the learning disabled compared to the children with no learning problems and that there is no difference between the two groups. Therefore leading to the questioning of the role of vision in terms of its role on learning disabilities.

In South Africa the data regarding the statistics on how big the problem is, is not available as mentioned above. Richter (2000) and Naidoo, Raghundan, Mashige, Govender, Pakharel and Ellewein (2003) did their studies on the children who were not categorised as learning disabled.

1.2 MOTIVATION FOR THIS STUDY

In South Africa the criteria used for referring children to the schools of the learning disabled is not very clear. According to the principals of the few schools of the learning disabled consulted, most of their learners are referred to their schools due to the concerns raised by parents, poor academic performance resulting in them lagging behind compared to the children in the same age group, the intelligent quotient (IQ) and the educational psychologists (personal communication, 2005). The study was to establish if a comprehensive evaluation including visual evaluations of children labelled as learning disabled is endorsed by the South African Education policies. If it is not, then this study aims to highlight the role of the optometrist in the evaluation and co-management of reading related vision problems. The current study highlights the importance of the screening of visual deficiencies in both the mainstream and the schools of the learning disabled, to exclude any hindrances to the process of learning. This study is also conducted due to the fact that published data in South Africa on the prevalence of visual deficiencies in children with learning disabilities is scant.

1.3 AIM AND OBJECTIVE

1.3.1 The aim of the study is formulated as follows:

- To determine the prevalence of visual deficiencies in children from the schools of the learning disabled compared to children in the mainstream schools.

1.3.2 The objectives of the study are as follows:

- To determine the demographic profile of learners in the two groups.
- To determine the visual status of each learner in each of the two groups.
- To compare the prevalence of the various vision deficiencies between the children from the learning disabled and mainstream schools.
- To determine the strength of the relationship between the age and the specific vision deficiency, then gender and the specific vision deficiencies.

1.4 RESEARCH METHODOLOGY

The study is a cross sectional survey to establish the prevalence of visual deficiencies in children with learning disabilities compared to children in the mainstream schools. The data collected was thus statistically analysed using the bivariate method to explore the relationship between a high prevalence of visual deficiencies and the mainstream or the schools of the learning disabled. The hypothesis tests (Pearson Chi-Square tests) were used to classify subjects in relation to two separate quantitative variables, Cramer's V tests were used for the purpose of determining their degree of association.

1.5 DEFINITION OF CONCEPTS

1.5.1 Vision

Hoffman (in Scheiman & Rouse, 1994) defines vision as a continuous integrative process divided into three components:

1) visual acuities including refractive status
2) visual efficiency skills composed of oculomotor, accommodative and binocular vision skills
3) visual perceptual-motor skills

These three components together, according to Hoffman (in Scheiman & Rouse, 1994) constitute the visual information processing system necessary for efficient reading and learning.

Scheiman and Wick (2002) describe the model of vision slightly different from Hoffman's (in Scheiman & Rouse, 1994) model. According to Scheiman and Wick (2002), vision is composed of

1) The Visual integrity pathway (including eye health, visual acuity and refractive status);
2) visual efficiency (including accommodation, binocular vision and eye movement skills); and
3) visual information processing (including visual spatial, visual analysis and visual motor integration skills).

Scheiman and Wick (2002) thus suggested that to adequately identify the learning or reading related vision problems, it is essential to fully evaluate all three interrelated areas. Although Scheiman and Wick's (2002) model of vision has many standard features that would be useful to follow in the current study, it will not be used entirely. The researcher intends using aspects of this model and supplements some components with other more recent methodologies.

1.5.2 Visual deficiencies

Scheiman and Rouse (1994) stated that the process of reading can be affected by uncorrected refractive errors, in particular hyperopia and anisometropia, accommodative and vergence anomalies and oculomotor dysfunctions. Symptoms such as ocular discomfort (including asthenopia, headaches and tearing eyes), blurred vision when reading, and diplopia of the text, are associated with visual deficiencies interfering with automatic information processing for successful reading (LaBerge & Samuels, 1975) (in Scheiman & Rouse, 1994). Successful reading requires accurate ocular motilities and the dysfunction thereof has been found to be related to increased refixations, delay of word recognition, and slow comprehension (McConkie, Zola & Grimes 1991, in Scheiman & Rouse, 1994).

The most frequently encountered disorder in learning disabilities is the reading disability although there is a diversity of disorders in children with learning disabilities including mathematics, written or oral difficulties, perceptual problems and disorders of attention. Borsting (1991) stated that visual deficiencies may lead to children being labelled as having attention deficit, due to them being unable to stay focused on a task. According to Scheiman and Rouse (1994) attention capability is mirrored by smooth-pursuit ability.

1.5.3 Learning disability

The following discussion concerns the various theories and studies that contributed towards the generation of the definition of learning disabilities.

Various learning disabilities theories Strauss (1947), Piaget (1964) (in Scheiman & Rouse, 1994) and Frankenberger (1991), Kephart (1971) contributed towards the generation of a suitable definition for learning disabilities. These theories proposed that common elements such as neurological dysfunction, uneven growth pattern, difficulty in academic and learning tasks, discrepancy between potential and achievement, also formed part of the definition of learning disabilities.

The National Advisory Committee on Handicapped Children (1967) (in Silver & Hagin, 2002); National Joint Committee on Learning Disabilities, 1988; Individuals with Disabilities Education Act (1990); The Interagency Committee on Learning Disabilities (1987) (in Lerner, 1993) and several authors such as Hammill (1990); Lyon (1996); Kiely, et al. (2001); Silver & Hagin (2002); Keogh (2005), define learning disability as one or more disorders of the basic psychological processes concerned with understanding or usage of language in speech or in writing. These disorders include the inadequate ability to listen, think, speak, read, write, spell or do mathematical calculations. Conditions such as perceptual handicaps, brain injury, minimal brain dysfunction, dyslexia and poor general development are included in this definition.

Willows (1996) stated that depending on which approach is taken, the term learning disability could mean several different things. Thus medical terminologies such as dyslexia, dysgraphia, dyscalculia and attention deficit disorder (ADD) or attention deficit hyperactivity disorder (ADHD) may be associated with difficulties in reading, writing, mathematics and attention respectively. From the above perspective it can be concluded that a range of medical or psychological disabilities or conditions may be identified that directly or indirectly may be associated with or contribute to a learning disability.

Although categorization into types of learning disabilities may have been useful in a study such as is conducted here, the practical implementation of categorization was not feasible within this study. The reason for the exclusion of categories of learning disabilities was mainly due to the confidentiality of information that was maintained by the sample schools in the study. Target schools opted not to divulge specific information regarding the type of learning disability in order to protect subjects participating in the study. The subjects with learning disabilities were thus categorized based on the schools they were attending.

Therefore the current study was mainly conducted to investigate the prevalence of visual deficiencies in children who have been broadly described or labelled as having a learning problem (specific and non-specific). Research subjects adhering to the sampling criteria were identified mainly by school teachers and educational psychologists, whilst specific measures used to label subjects as learning disabled were not made available to the principal investigator. Although specific categorization may be perceived as a limitation it is possible that subjects may have been described as learning disabled whilst teachers and psychologists were in fact not aware of the children's vision deficiencies. The same applied to the mainstream school since it did not provide information about the academic performance of their learners, therefore children with learning problems could have been amongst those evaluated.

The subsequent chapter will discuss the schools of the learning disabled and the mainstream schools in the South African context.

1.5.4 Mainstream and the school of the learning disabled

Mainstream schools refer to government schools in this study. Education White Paper 6 (2001) explains that the mainstream schools are about getting learners into a particular existing system. It further states that learners are integrated in "normal" classroom routines, and the focus in these schools is on changes that need to take place in learners so that they can "fit in".

The schools of the children with learning disabilities are also referred to as the special schools. The special schools are for learners with a wide range of educational needs including learners requiring psychological and educational guidance, career and counselling service, learners with physical, neurological, varying degrees of mental disabilities, emotional, and learners with behavioural difficulties. According to the Education White Paper 6 (2001) the special schools include learners with visual, speech and language difficulties including those from disadvantaged backgrounds (in poverty, suffering malnutrition, street children), as well as learners with general and specific learning disabilities.

1.6 LIMITATIONS OF THE STUDY

The study is limited by the fact that little data could be obtained regarding specific learning disorders in the target population. This data was regarded as confidential and therefore inaccessible to the researcher. Although this aspect may be regarded as limiting the study, the researcher is of the opinion that the study still makes a contribution by presenting information relevant to optometry and that the primary aim was to gather such information and not information pertaining to learning disorders.

Another limitation anticipated were the errors that could occur in the normal process of collecting data. Specifically it was anticipated that visual evaluation procedures may be affected by variables such as time, lack of respondent familiarity with evaluation procedures, similar target sizes, and the same fieldworkers involved with visual evaluations throughout. In order to minimize consistency problems in data collection, workshops were conducted with fieldworkers before the visual evaluations were done.

1.7 LAYOUT OF CHAPTERS

Indicate the different chapters and how the study will progress.

- **Chapter 1**
  It discusses the introduction to the study. This chapter indicates the actuality of the topic and introduces the goals, objectives, main concepts to be used as well as the methodology to be followed.

- **Chapter 2**
  This chapter discusses learning disabilities in South Africa, including the statistical analysis concerning schools available for the learning disabled and the distribution of different disabilities contributing to learning disabilities. The discussion also includes the explanation of mainstream schools according to the South African context.

- **Chapter 3**
  It discusses the literature review regarding all components of visual deficiencies related to learning problems. The effects of all these components on learning are also discussed based on the different studies done. The

current studies conducted in South Africa related to the spread of refractive errors in the school going age population are also discussed.

- **Chapter 4**

  In this chapter the design of the study is discussed, the sampling criteria, selection criteria, data collection and the tests performed on the respondents to collect data. The expected norms are discussed, as well as the statistical analysis method used.

- **Chapter 5**

  It discusses the results of the visual evaluations in the learning disabled and the mainstream group. The visual skills evaluated including the visual acuities, refractive status, accommodation, vergence system and the ocular motilities. The discussion includes the association of variables such as age and gender with visual deficiencies.

- **Chapter 6**

  The discussion includes the analysis of the results, regarding the different visual deficiencies related to learning (visual acuities, refractive status, accommodation, vergence system and ocular motilities). The limitations of the study are also included as well as recommendations for more research topics.

- **Chapter 7**

  It summarizes the results of the current study. The conclusion is discussed and recommendations are made motivating for further research based on the findings of the study.

1.8 CONCLUSION

Contradictory conclusions have emerged, in which various studies have concluded that visual deficiencies are more prevalent in the learning disabled compared to the children with no learning problems, and that there is no difference between the two groups in terms of the prevalence of visual deficiencies. The aim of the study is to establish if the visual deficiencies such as poor visual acuities, high refractive errors, accommodation insufficiency, poor vergence system and abnormal ocular motilities are more prevalent in the children from the learning disabled schools than from the mainstream schools. The correlational method is the type of study conducted, with the bivariate method used to analyse the data collected. The definition and the summary of the concepts used in this study such as vision, learning disabilities, the mainstream and special (learning disabled) schools in the South African context have also been discussed. The layout of chapters provides information in summary of the content of each chapter.

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CHAPTER 2

LEARNING DISABILITIES

2.1 INTRODUCTION

The current study was mainly conducted to investigate the prevalence of visual deficiencies in children who have been broadly described or labelled as having a learning problem (specific and non-specific). The definition of learning disabilities in chapter 1, describes it as a cluster of disorders including mathematics, reading, written or oral difficulties, perceptual problems and disorders of attention.

The following discussion will shortly review the definition of learning disabilities including the reading problems, displayed by children with learning disabilities. In the current study it has been found to be important to discuss all the characteristics associated with learning disabilities, although the selection criterion of the experimental group was not based on it, since that information was not made available to the investigator. The discussion of all the characteristics associated with learning disabilities in the current study has been found to be essential because to isolate them and only concentrate on reading disabilities will not make sense in the discussion of our results.

2.2 CONCEPTUALIZATION

2.2.1 Learning disabilities

Garzia (in Scheiman & Rouse, 1994) and Keogh (2005) stated that even though the definition of learning disabilities is broad, as a theoretical model it is vague and not testable. This makes it difficult for learning disabilities to be diagnosed and treated by different professional specialities (educational specialist, an audiologist, a developmental linguist, a neurologist, a neurophysiologist, or an optometrist) since they do not share a completely common view of what constitutes a learning disability. Griffin, Christenson, Wesson & Erickson (1997) in agreement with

Solan (in Scheiman & Rouse, 1994) stated that the definition of learning disabilities is concerned with the broad spectrum of academic difficulties (listening, speaking, reading, reasoning and mathematics) and does not restrict itself to one domain (for example dyslexia), thus making it difficult to be diagnosed. The different domains according to Griffin, et al. (1997) that could be diagnosed and treated by different professional specialists are mentioned by Lerner (1993) as: disorders of attention, failure to develop and mobilize cognitive strategies of learning, poor motor abilities, perceptual and information processing problems, oral language difficulties, reading difficulties, written language difficulties, mathematics difficulties and inappropriate social behaviour.

These characteristics mentioned by Lerner (1993) are also included in the definition of learning disabilities by the National Advisory Committee on Handicapped Children (1967) (in Silver & Hagin, 2002); Individuals with Disabilities Act (1990); The National Joint Committee on Learning Disabilities (1988); The Interagency Committee on Learning Disabilities (1987) (in Lerner, 1993). Therefore in agreement with Solan (in Scheiman & Rouse, 1994) and Silver & Hagin (2002) the definition of learning disabilities is broad and not specific, due to a cluster of disorders associated with learning disabilities.

2.2.2 Reading difficulties

Willows (1996) and Hammil (1990) suggested that children with a reading age two or more years behind their chronological age are referred to as reading disabled, which is a common feature in individuals with learning disabilities. Sawyer and Butler (1991) and Vellutino, Fletcher, Snowling and Scanlon (2004) found these children with reading difficulties to have problems with effectively interacting the text or merging the information with what they already know, with the primary cause being lack of phonetic, syntactic or semantic processing of language. Klatzky (1984) (in Sawyer & Butler, 1991) stated that the ability to remember involving short- and long term memory is critical in the acquisition of speaking, listening, reading, and writing skills.

According to Griffin, et al. (1997), individuals with reading difficulties may have other contributory factors such as low IQ, educational deprivation, bilingual confusion, vision, auditory or sensory integration or attention problems. These individuals are regarded as having general reading dysfunctions.

Critchley (1964) (in Ridder, Borsting, Cooper, McNeel & Huang, 1997) defined dyslexia using the exclusionary approach, that the dyslexic individuals, read below the expected grade levels but adhere to the criteria of normal intelligence, no emotional problems, no sensory deficits and normal educational opportunity. Lyon (1995) stated that dyslexia restricted itself to one domain of academic difficulty (reading) including phonological processing.

Hynd (1992) and Galaburda (1990) (in Lerner, 1993) proposed that specific reading dysfunctions be referred to as dyslexia when all possible other etiologies are ruled out. They further defined dyslexia as a coding problem involving written language thus resulting in poor reading, spelling and writing. A perspective consistent with Bender's (1992) explanation, that dyslexics have recognition problems and thus poor comprehension.

Border (1973) (in Griffin, et al. 1997) based on the exclusionary aspect of the definition by Critchley (1964) (in Ridder, et al. 1997), subdivided the dyslexic population using the phonetic and eidetic processing of words. Border (1973) (in Griffin, et al. 1997) further stated that there are three dyslexic subtypes:

- dyseidetic (difficulty in making immediate sight-sound match)
- dysphonesia (impairment in phonetic ability to decode unfamiliar words)
- dysnemkinesia (characterized by an abnormally high frequency of letter reversals)

Camp and Dolcourt (1977), Flynn and Deering (1989) and Ridder, et al. (1997) also confirmed that dyslexia has three subtypes, with Griffin, et al. (1997) further stating that the three subtypes can be permuted resulting in approximately 7 subtypes. From this perspective dyslexia is a term used for children with specific reading problems, whereby there is lack of phonetic, syntactic or semantic processing of language resulting in poor spelling, writing and reading. Therefore these disorders lead to the hindrance of the learning capability.

The common characteristics to be discussed subsequently including reading disabilities mentioned above are all included in the definition of learning disabilities.

2.2.3 Disorders of attention:

Brown & Waynne, (1984), Hinshaw (1987) and Wong (1996) stated that the symptoms of disorders of attention such as inattention, impulsivity, hyperactivity and antisocial behaviours including fighting, stealing, lying and truancy are common in children with learning disabilities. They further stated that children with the above mentioned characteristics have difficulty sustaining attention to a task over time, focusing attention, and completing their work. Thus leading to poor academic performance due to lack of sustaining attention to any task including reading and learning.

2.2.4 Poor motor abilities

Rosengren (2003) stated that the emergence of motoric milestones is driven by maturational changes common to all the members of a species in agreement to Piaget's (1970) theory. Strauss (1947) (in Scheiman & Rouse, 1994); Ayres (1981, 1978)); Kephart (1971); (in Lerner, 1993); Smith, et al. (2003) and Feldman (2004), have researched the relationship between motor development and learning from a neurophysiologic perspective. They have thus concluded that early motor learning is an essential part of the build-up of brain cell assemblies necessary for other cognitive functions. Thus laying a good foundation for cognitive development, disorders in the development of motor abilities have been found to hinder the learning capacity of children.

2.2.5 Perceptual and information processing problems

Griffin, et al. (1997), stated that perceptual and information processing skills are those psychological processes involving motor, linguistic and memory functions. Groffman (in Scheiman & Rouse, 1994), in support of Griffin, et al. (1997) further stated that perceptual and information processing skills, form the foundation in cognitive development and are directly linked to learning. According to Garzia (in Scheiman & Rouse, 1994) and Wachs (1981) the visual efficiency skills (accommodation, vergence and ocular motilities) including the visual acuities, refractive status and perceptual skills are involved in the processing of information. Therefore deficiencies in these processes are basic limitations interfering with a child's learning capacity.

Deficits of the perceptual and information processing skills result in children encountering problems when confronted with symbolic materials. This is due to inadequate orientation of space and time which is referred to by Kephart (1971) as the basic realities of the universe surrounding the species.

2.2.6 Oral language difficulties

Badian (1988) stated that language problems of any form are the underlying basis for many learning disabilities. Sawyer & Butler (1991) suggested that oral language includes lack of phonological awareness, delayed speech, disorders of grammar, deficiencies in vocabulary acquisition and poor understanding of oral language. Language disorders also appear in written language skills, affecting reading, writing or spelling. Stark (1988) (in Sawyer & Butler, 1991) studied the phonological development among 45 first-born infants, ages two weeks to 18 months, who were apparently normal according to birth histories and paediatric reports. Thirty of these children were evaluated again, when they were in grade two. She then concluded that reading disabilities that existed at a later stage were due to earlier identified lag in phonological development. She further stated that such disorders of oral language could improve if identified at an early age, but can reappear several years later as a reading disability.

2.2.7 Written language difficulties

Newcomer & Barenbaum (1991) and Anderson (1982) concluded that children with learning disabilities have problems in the acquisition and use of written language which involve copying tasks, spelling and composition. Newcomer & Barenbaum (1991) further stated that the important elements of a written composition include the mechanics of writing, vocabulary and fluency. These elements refer to capitalization, punctuation, spelling, usage of mature words, and number of words, adjectives or subordinate clauses per sentence. In addition to copying errors other errors may include letter height, spacing within words, letter proximity to the line and word spacing. Blandford & Lloyd (1987) suggested that these problems of producing text may impede other writing processes such as spelling and generating ideas, since they have a negative impact on comprehension.

2.2.8 Mathematics difficulties

According Baroody & Ginsburg (in Swanson, 1991), mathematics knowledge develops well before school going age. Informal mathematics knowledge prior to going to school is based largely on counting experiences, providing an important basis for formal learning in school which is largely written or symbolic mathematics. Ginsburg, (1989) (in Swanson, 1991) also stated that mathematics knowledge involves an understanding of the entire number system and is dependent on spatial relationship concepts (up-down, over-under, top-bottom, high-low, near-far, front-back, beginning-end and across). Lerner (1993) further suggested that the spatial relationship concepts are difficult to understand in children with mathematics difficulties. From this perspective it appears that mathematical learning problems may be associated with a variety of disabilities in other areas such as cognition, spatial relationships, symbol recognition, language, communication and visual perception.

2.2.9 Failure to develop and mobilize cognitive strategies of learning

Piaget's (1970) maturational theory (quoted in Feldman 1986) provides a solid framework leading to a better understanding of the development of cognitive skills. According to this theory the individual's ability to learn depends on the child's maturational status, which is composed of a sequential progression of four stages. The four broad-scale stages referred to in his theory are sensory-motor, preoperational, concrete and formal operations. Boom (1992) and Levin (1986), (in Feldman, 2004) revised Piaget's (1970) stages of cognitive development, and provided a logical, consistent, functional working system regarding the process from birth to early adulthood contributing to the individual's learning abilities.

Lerner (1993) and Koppitz (1973) state that attempts to speed up or bypass the maturational process by forcing the child to perform academic tasks beyond their capacity can create a problem of learning, since at each stage of development the child is capable of learning only certain cognitive tasks.

2.2.10 Inappropriate social behaviour

Bryan & Perlmuter (1979) and Bryan & Sherman (1980) (in Wong, 1991), observed students on videotapes before identifying and differentiating those with learning disabilities from those with no learning disabilities. A few minutes after observing the students, children with learning disabilities were perceived more negatively (poor social skills, rejection by their peers, poor self-perception) than their peers with no learning problems.

Parker and Asher (1987) (in Wong, 1991), concluded that the negative outcomes associated with being rejected include school dropout, adjustment difficulties, and loneliness. Vaughan (in Wong, 1991) and Bender (1987) explained that some students with learning disabilities do poorly in social situations, since they have difficulty meeting basic social demands of everyday life even though they may be average or above average in verbal skills or intelligence. It appears then that poor or inadequate social behaviour may be associated with learning disabilities.

The process of learning and cognitive development depends on the maturity of the child based on their developmental level (Piaget, 1970 (in Feldman, 2004), ability to sustain attention on a task over time (Brown and Wayne, 1984; Hinshaw, 1987), good phonetic, syntactic or semantic processing (Badian, 1988), and good perceptual skills for the interpretation of information acquired kinaesthetically, visually or through the auditory system (Kephart, 1963, 1967 in Lerner,1993). Therefore the above mentioned characteristics including vision are associated with the process of learning. Although the characteristics associated with learning disability are described elaborately in this chapter, it is important to remember that in the current study the respondents were purposively selected on the basis of the general "label" of learning disability.

2.3 LEARNING DISABILITIES IN SOUTH AFRICA

The following review clarifies the South African situation concerning learning disabilities and the current policies in place, to assist children with learning disabilities. The statistics concerning the number of schools (primary, high and tertiary schools) for children with learning disabilities, in the nine (9) provinces of South Africa will also be discussed. The discussion will also include the distribution of disabilities into different categories including visual, hearing, physical, mental, multiple and non-specified disabilities per province.

The following discussion will assist us in understanding the justification for doing this study. A link has been identified when looking at the analysis of the data from the South African Education Management Information System (2001), regarding the distribution of various disabilities among learning disabled persons. Although the information regarding the level of education (primary, high, or tertiary institutions or adult based education) was not specified in the data (table 2.1 & 2.2) the extent of disparities between the number of learners in the special schools and the overall incidence of visual disabilities was of concern.

According to the South African Education Policy Document (White Paper 6, 2001), children with learning disabilities are referred to as children with special needs. This document drafted by the Ministry in the Office of the Deputy President stated that special needs education included learners with a wide range of educational needs including learners requiring psychological and educational guidance, career and counselling service, learners with physical, neurological, varying degrees of mental disabilities, emotional, and learners with behavioural difficulties. The policy also focuses on learners with speech and language difficulties including those from disadvantaged backgrounds (in poverty, suffering malnutrition, street children), as well as learners with general and specific learning disabilities.

The White Paper 6 (2001) was originally drafted in October 1996, by the Ministry of Education, which appointed the National Commission on Special Needs in Education and Training and the National Committee on Education Support Services to investigate and make recommendations on all aspects of "special needs and support services" in education and training in South Africa for all levels of education including the primary, secondary and tertiary education.

The White Paper 6 (2001) was then created to address the government's concern to provide education and training that is responsive and sensitive to the various learning needs as mentioned in the White Paper on Integrated National Disability (1996). Based on the data from the Education Management Information System (EMIS) (2001), the distribution of special schools, and learner enrolment across all departments of education was found to be as follows (Department of Education, White Paper 6, 2001)

Table 2.1:

Learner enrolment and special schools

Provinces	No. of Special Schools	No. of Learners in Special Schools	% of Learners in Special Schools	% of Total No. of Special Schools in Province
Eastern Cape (EC)	41	6 483	0.28%	10.79%
Free State (FS)	19	3 127	0.40%	5.00%
Gauteng	96	25 451	1.62%	25.26%
KwaZulu-Natal (KZN)	58	7 631	0.28%	15.26%
Mpumalanga (MP)	15	2 692	0.29%	3.95%
Northern Cape (NC)	8	1 392	0.68%	2.11%
Northern Province (NP)	19	4 250	0.23%	5.00%
North West (NW)	42	4 364	0.46%	11.05%
Western Cape (WC)	82	9 213	0.96%	21.58%
Totals	**380**	**64 603**	**5.2%**	**100.00%**

The distribution of various disabilities was further divided into different categories including visual, hearing, physical, mental, multiple and non specified disabilities per province (see Table 2.2 below).

Table 2.2:

Census data indicating distribution of learning disabled persons per province

Province	Vision	Hearing	Physical	Mental	Multiple	Not Specified	Total	% per province	% of population
EC	161898	68531	115717	41432	35997	38604	462179	17.39	1.14
FS	133614	33045	41960	13947	16461	18127	257154	9.68	0.63
Gaut	211769	59868	69936	24033	26030	63906	455542	17.14	1.12
KZN	183758	76034	129894	42646	24895	44863	502090	18.89	1.24
MP	98322	31895	41381	12211	9019	19085	211913	7.97	0.52
NC	18529	6083	9052	3791	2403	7137	46995	1.77	0.12
NP	113088	51416	60078	22578	16019	33690	296869	11.17	0.73
NW	129442	37571	54706	17768	16913	23134	279534	10.52	0.69
WC	40603	18965	35051	14146	6499	30174	145438	5.47	0.36
TOT	1091023	383408	557775	192552	154236	278720	2657714	100.0	6.55
% per disability	41.05	14.43	20.99	7.25	5.80	10.49	100.0		
% per population	2.69	0.94	1.37	0.47	0.38	0.69	6.55		

Regarding the data given above, the extent of disparities between the number of learners in the special schools and the overall incidence of disability is a matter of concern. For example in Gauteng 1.62% learners were enrolled in special schools, when the distribution of the learning disabled persons is 17.14%, and this pattern is repeated across provinces. Analysis of the data reveals a high prevalence (41.05%) of visual disabilities in children with special needs, compared to the other disabilities which include hearing (14.43%), physical (20.99%), mental (7.25%), multiple (5.80%) and not specified disabilities (10.49%).

According to Garzia (in Scheiman & Rouse, 1994) (Scheiman and Wick, 2002) vision is a broad term including refractive status and visual acuity, visual efficiency and visual perceptual skills. Of the visual disabilities mentioned the focus of this study is to identify the fundamental functional visual skills according to Scheiman and Wick (2002). In the current study the prevalence of visual deficiencies including uncorrected refractive errors, reduced visual acuities, poor ocular motilities, accommodation dysfunctions, poor vergences and poor ocular health status will thus be investigated and compared to that of children in the mainstream school.

According to the data released by the Education Management Information System (EMIS) (2001), the distribution of special schools, and learner enrolment across all departments of education was found to be not in balance. Children with learning problems are still in the mainstream schools because there are not enough special schools. Thus it is not surprising to find children with learning disabilities in the mainstream schools.

It is thus not clear as to which part of visual disabilities is more prevalent, is it the functional visual skills (including the visual integrity pathway and the visual skills efficiency) or the visual information processing skills? This opens more room for future research to be conducted since this study's objective is to establish if functional visual deficiencies are more prevalent in the mainstream or in children with learning problems.

2.4 MAINSTREAM SCHOOLS IN SOUTH AFRICA

Muthukrishma (2002) stated that in the previous educational system (before 1994 South African democratic elections) mainstream schools included all types of learners (including learners with learning disabilities and those without). Thus the drafting of the White Paper on Education and Training (1996) that advocated an inclusive education policy known as outcomes based education, giving recognition to the wide diversity of needs in the learner population. The revised education system advocates for providing educational support to a diversity of learners to ensure that every learner is being taught at their own pace and receives optimal attention. One of the policies outlined by the White Paper (1996) was to indicate how learners with disabilities (learning) will be identified, assessed and incorporated into special, full-service and ordinary schools in an incremental manner (depending on their level of education).

Muthukrishma (2002) stated that education policy documents such as the White Paper on Education and Training (Department of Education, March 1995); White Paper 2: The Organization, Governance and Funding of Schools (Department of Education, November 1996); White Paper on an Integrated National Disability Strategy (Ministry in the Office of the Deputy President, 1996); and the South African Schools Act of November 1996 used the term "special needs" to refer to learners with disabilities and those experiencing learning difficulties. Furthermore from the policy documents emerged the two categories of learners: those who are the majority with ordinary needs and a smaller minority with special needs who require support and specialised programmes to engage in some form of learning. The impact of these policies was to address the fact that only approximately 20% of the learners with disabilities are accommodated in special schools whilst the majority who needs educational support are in mainstream schools and are not receiving educational support.

The Education White Paper on Special Needs (2002) stated that according to the World Health Organisation's calculations between 2.2% and 2.6% of learners in any school system are identified as disabled or impaired. In applying these percentages to the South African school population an upper limit of about 400,000 disabled or impaired learners is projected, with recent statistics showing approximately 64,200 learners with disabilities or impairments accommodated in about 380 special schools. Therefore it can be concluded that potentially 280,000 learners with disabilities or impairments may be in need of special educational support for a learning disability, but are not being accommodated in special schools nor do they receive educational support.

Muthukrishma (2002) and Fakier and Waghid (2004) further stated that curriculum 2005 (Outcome Based Education) which was considered to contribute positively towards the reform of the South African education system, encountered problems in its implementation due to lack of capacity to train teachers, lack of funds at provincial level, the complex nature of the curriculum, inadequate textbooks and learning materials available to schools.

In the current study the researcher was interested in establishing the extent to which children with special needs, specifically regarding learning ability were present within the mainstream school system. For this purpose she will conduct the study in a main stream as well as a specialized facility for learning disabled children to establish a comparison between these two types of schools regarding the prevalence of visual problems. I.H. Harris is a mainstream school in Johannesburg (Doornfontein). It was selected to participate in this study due to proximity and the willingness of the school authorities to let their learners participate in the study. From personal communication (2006) with the school secretary the majority of the children in the school come from disadvantaged backgrounds. According to her in all the classes there is one or two, if not more, children who are lagging behind in terms of their academic performance. Therefore it will not be surprising to find children with learning disabilities amongst the mainstream school respondents, forming part of those children with disabilities who are not accounted for by our educational system. It is perhaps more likely that learning as well as visual deficiencies may be more prevalent in this school due to the socio-economic factors mentioned.

Based on the mentioned characteristics of the participating mainstream school it may be an ideal school to select for purposes of evaluating visual skills. If it is found that there is no difference in visual problems in the mainstream school compared to specialized schools for the learning disabled, it may then be concluded that there is a lack of effective and comprehensive visual evaluation in mainstream schools. Though such finding would not be generalizable to all schools such occurrence may be the topic of future research.

2.5 CONCLUSION

The learning disabled are identified/categorized according to the various disorders or characteristics stated in the definition of learning disabilities and Lerner (1993). The education system in South Africa has taken into cognisance the various disabilities and has endorsed a policy that children with the various disabilities be accommodated in the special schools. Since the distribution of the special schools does not accommodate all learners with learning disabilities, inclusive education was introduced which was also referred to as the outcome based education. Problems in its implementation were encountered thus it is not surprising to find children with learning problems in the mainstream schools.

The following literature review will thus discuss the visual deficiencies generally encountered in children with learning disabilities. Studies conducted regarding the prevalence of visual deficiencies in children with learning problems will also be discussed.

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CHAPTER 3

LITERATURE REVIEW: VISUAL DEFICIENCIES

3.1. INTRODUCTION

The previous chapter described the common characteristics in children with learning problems including reading disabilities and attention disorders which have a negative impact on academic performance. Optometrists do not treat the learning or reading disabilities but concentrate more on visual disorders since they may be contributory towards learning disabilities. Vision is actually not the cause of learning problems but if the learner has learning problems, visual disorders can impact on their learning capability. The visual skills (including the visual acuities, refractive status, accommodation, vergence, ocular motilities and an intact ocular health status) important in the acquisition of knowledge will be discussed in this chapter.

3.2 VISION

Griffin, Christenson, Wesson and Erickson (1997) modelled vision as a multidimensional process involving the gathering of light, processing of impulses and integration of visual impulses together with other sensory impulses and the motor system. Garzia (in Scheiman & Rouse, 1994) proposed that this model considered the anatomic and functional characteristics of the visual system, including the refractive status, visual acuity, ocular health, accommodation, vergence system, ocular motilities, and the information processing.

Garzia (in Scheiman & Rouse, 1994) further stated that the dysfunctions and abnormalities in one or more of the mentioned visual components (refractive status, visual acuity, ocular health status, accommodation, vergence, ocular motilities and the visual information processing) can be associated with learning problems.

The focus of this study is on the assessment of refractive status, visual acuities, ocular health and the visual efficiency skills (accommodation, vergence and ocular motilities) since these are the standard features of a functional vision examination (Garzia, in Scheiman & Rouse, 1994 and Scheiman & Wick, 2002).

3.2.1 Visual acuities

Saunders (in Leat, Shute & Westall, 1999) stated that visual acuity measurement involve the description of finest detail (or smallest object) which a person can perceive. She further mentioned that visual acuity refers to the spatial limit of visual discrimination within which obvious subdivisions can be recognized including detection, resolution, identification and hyper acuity. Numerous tests are available for testing visual acuities in children ranging from letter optotypes (Allen, 1957 in Rosenbloom & Morgan, 1990), including isolated letter optotypes, isolated line as well as full chart presentations of letter optotypes. The telebinocular was also mentioned (in Rosenbloom and Morgan, 1990) as a device for the evaluation of visual acuity included in the series of the screening procedures.

Verney (1958) (in Borish, 1970), Grisham and Simons (1986) suggested that visual acuity of 6/6 or better is a prerequisite of visual information processing related to reading. They further stated that to read effortlessly, the brain has to receive a clear image from the prescribed text for fine interpretation. In agreement with Verney (1958) (in Borish, 1970) and Griffin, et al. (1997) stated that poor visual acuity of 6/9 or less will result in a blurred optical image, which can hinder the processing of visual information, and thus contribute to learning disabilities.

Studies reported by researchers such as Eames (1948), Chernick (1978), Rosner and Rosner (1987) in which the prevalence of the visual skills were evaluated including visual acuities, refractive status, accommodative, vergence system and ocular motilities, compared children with and without reading problems. In both the poor readers and the randomly selected control group, the occurrence of reduced visual acuities (at distance and near) was found to be the same.

Chernick (1978) and Evans, Drasdo and Richards (1996) visually screened poor readers, identified as children reading at two or more years below grade level, using the Stanford Achievement Tests. The ages of these children ranged from 8 - 11 years. Visual acuities in these studies were measured using the Snellen Acuity charts at both distance (6m) and near (40cm). The prevalence of reduced distance visual acuity (6/9 and below) was approximately 5%, and at near (6/9 and below) was approximately 3.75%, and were thus found to be insignificant in affecting reading performance.

Grisham and Simons (1986) reviewed studies ranging from 1932 to 1973 and compared the distance acuity of subjects with reading problems, to those with normal or above average reading ability. Their review revealed no differences for distance vision between the two groups. To the contrary, in the same review, Grisham and Simons (1986) quoted studies of Fendrick (1935), Spache and Tillman (1962) which produced evidence supporting that the relationship between poor reading and reduced near acuity in particular binocular acuity existed. Grisham and Simons (in Rosenbloom & Morgan, 1990) stated that the relationship between low near visual acuity and reading performance is inconsistent. They further stated that most studies investigating this relationship between poor near visual acuity and poor reading performance, utilized methods that had doubtful validity and reliability for example the Brewster type stereoscope. The study by Robinson (1968) (in Grisham & Simons, 1986) concluded that there was no correlation between reduced near vision and poor reading skills. According to Grisham and Simons (1986) and Robinson's (1968) results were flawed since the mechanical-optical screening device (Ortho-Rater) used for near point testing was found to have poor reliability (.46) by Robinson (1968) herself.

A conclusion was thus reached that reduced distance vision is not related to reading performance, and a relationship between poor reading and reduced binocular near vision may exists.

3.2.2 Refractive status

Hirsch (1966) (in Borish, 1970) concluded that the sum of a series of refracting surfaces, such as the corneal and lenticular surfaces, a variety of different media indices (aqueous, lens cortex, and vitreous), as well as the distances separating each surface and index determine the refractive status of the eye. Borish (1970), Leat, et al. (1999) in agreement with Hirsch (1966) (in Borish, 1970) further stated that the refractive anomalies are due to the imperfect coincidence of the principal focus of the eye with the retina, when the eye is relaxed or not accommodating. Thus resulting in different types of refractive errors referred to as hyperopia, myopia and astigmatism.

Grisham & Simons, (1986), quoted Eames (1932a, 1935b) as the most widely known studies, which compared the refractive error distribution in the reading disabled and the randomly selected sample of school children. The prevalence of hyperopia was found to be higher among the reading disabled than in the control groups. According to Grisham and Simons (1986) the Eames (1932a, 1935a) studies added value to the data due to supporting factors such as the large sample size, and the standardized refractive techniques that were used. Flaws were however identified in the experimental design used such as, the study did not report on the selection criteria employed for selecting the group age, IQ, or reading test scores. The mentioned flaws thus tended to weaken the positive results.

Subsequently, Eames's (1948) study compared the refractive status of poor readers, eye clinic patients (referred to as the ophthalmic cases) and a randomly selected sample of children. The median ages were 9 years and 8 months, 11 years and 6 months, and 10 years and 8 months, for the poor readers, the eye clinic patients and the randomly selected group respectively. The refractive status of the three samples was evaluated using the retinoscope and subjective refraction.

The prevalence of hyperopia of 1D or more in the eye clinic patients was 50%, 43% in the poor readers and 20% in randomly selected children. The prevalence of myopia of 1D or more was the same among poor readers and the randomly selected children, eye clinic patients presented with a high frequency of myopia. A 4% prevalence of hyperopic astigmatism 1DC or more was exhibited by the randomly selected sample of children, while the poor readers displayed 6% prevalence and the eye clinic patients exhibited 2%. The prevalence of myopic astigmatism was the same (1%) for the three groups.

Grisham and Simons (1986) who in their literature review identified flaws in Eames's (1932a, 1935b) studies also critiqued the 1948 study stating that similar to the earlier studies the reading disabled sample was drawn from a clinical population, where one would expect to find a predominance of children with significant refractive errors, and which could account for the high frequency of hyperopia. This is indeed true for Eames's (1948) study in which a higher prevalence of hyperopia was found in children referred to the eye clinic than in the randomly selected sample and the learning disabled sample.

Eames (1955) further investigated the influence of hypermetropia and myopia on reading achievement. The Gates Silent test was used to determine the children's reading level. In this study children in the 3rd and 4th grades were divided into three groups according to their refractive status, hemitrope (children without any refractive errors), myopes and hyperopes. Amongst the good readers no differences were detected in the reading achievement across the three refractive states. Contrary to that amongst the children with the lowest reading level hyperopia was found to be more prevalent.

Rosner and Rosner (1987), in their retrospective study agreed with Eames (1932a, 1935b, 1955), by finding a higher prevalence of hyperopia in children with learning disabilities than in children with no learning disabilities (Sucher & Stewart, 1993). Rosner and Rosner (1987) also found the prevalence of moderate myopia (-0.50D to -2D) in children with no learning disabilities to be 37% and 17% for significant myopia (more than -2D). In children with learning problems a prevalence of moderate and significant myopia was found to be 14% and 5% respectively. Astigmatism was found to occur about equally in both the children with learning problems and those with no learning problems. This study indicates a higher prevalence of myopia in children with no learning problems than in those with learning problems.

Eames (1964) again in his study found that the presence of anisometropia (unequal refractive errors in both eyes) had a negative impact on reading achievement. He found that there was a high prevalence of poor reading ability in children with anisometropia than in children with equal refractive errors. In correcting the anisometropia the reading ability of the experimental group (children with learning disabilities) improved.

Garzia (in Scheiman & Rouse, 1994) reported interactions between refractive status and visual-perceptual-motor development. He further stated that children with delayed visual-perceptual-motor development are at the risk of reading underachievement, thus concluding that an abnormal refractive status will have a negative impact on the reading skills of children. In agreement to Garzia's statements, Rosner and Gruber (1985), and Rosner and Rosner (1986) in their studies investigating differences in the perceptual skills of young myopes and hyperopes, found that uncorrected hyperopia contributed to having poor perceptual skills. Poor perceptual skills were found to impede the reading ability of children with uncorrected hyperopia compared to those with uncorrected myopia.

Norn, Rudziunski and Skydsgaard. (1969) (in Grisham & Simons, 1986) conducted a study in which they examined the relationship between hyperopia and specific reading dysfunctions. Congenitally word-blind students (dyslexics) and normally achieving students with ages ranging from 9 through 13 were matched for age, grade, and range of IQ. These two samples had their refractive error evaluated by means of cycloplegic refraction. A casual relationship between hyperopia and dyslexia was detected, since the prevalence of hyperopia in the dyslexics was found to be 33% and 33%in the normal readers.

Helveston, Weber, Miller, Robertson, Hohberger, Estes, Ellis, Pick and Helveston (1985), in agreement to Norn, et al.'s (1969) study also reported equal prevalences of refractive errors amongst poor, average and advanced readers. The study was conducted on a large sample of 1,910 children in the first three grades. Grisham and Simons (1986) in their literature review stated that insufficient information regarding the validity of this study was provided to validate the findings. Problems were found with the criteria used to determine significant refractive error and subsequent validity of the results of the refractive analysis.

The following discussion reports on the refractive status of children in South African mainstream primary schools. The discussion gives an indication of the kinds of refractive errors to be expected in the current study, in view of the fact that this study is focussed on comparing children in mainstream primary schools to those labelled as having learning problems in similar grades (3rd and 4th grades).

Richter (2000) conducted her study on 90 Caucasian primary school children (in grades 4, 5, 6 & 7) and evaluated their refractive status. The refractive status was evaluated using the auto refractor (Topcon RM-6000). Richter's study was found to be relevant since the children investigated were of the same age as the subjects selected for the current study. In her study only the right eye for each subject was evaluated, with 50 measurements taken from each eye over a period of 7 months. In Richter's (2000) study the mean auto refraction results for the 90 primary school children was found to be -0.31/-0.08 x 16 which was myopic for the children in grades 6 and 7, and less myopic for the children in the lower grades (4 &5).

Naidoo, Raghundan, Mashige, Govender, Pakharel and Ellewein (2003) in their study of refractive error and visual impairments in African children in South Africa investigated a broader group of children 5 to 15 years of age in the Durban area. The study included visual acuity measurements, ocular motility evaluation, retinoscopy and autorefraction. In this study the evaluations were in 35 clusters enumerated through a door-to-door survey. A total of 5 599 children were involved in the study, and of those only 4 048 had their refractive status evaluated due to lack of cooperation, media opacities and scissor or unclear reflex in the eyes with corneal or media opacities. Of the 191 children with reduced vision 63.6% was due to refractive error, amblyopia in 7.3%, retinal disorders in 9.9%, corneal opacity in 3.7% and other causes in 3.1%. The study found a low prevalence of reduced visual acuities in school-age children, with most problems caused by uncorrected refractive error.

The retinoscopy findings revealed that the spherical equivalent (SE) refractive error decreased with age from a median of +0.75D in the right eyes of 5-year-olds to +0.375 in 15-year-olds, with the median SE refractive error of +0.625D across all ages in both boys and girls. With autorefraction the median SE refractive error also decreased from +0.75 in 5-year-olds to +0.50 in 15-year-olds.

The two studies of Richter (2000) and Naidoo, et al. (2003) even though they were done on different populations Caucasians and Africans respectively, showed auto refractive results for children aged 5 – 7 years old clustered around emmetropia (low myopia, emmetropia and low hyperopia). Refractive status is one of the components of vision evaluated in this study in the age group of 8 – 13 year olds. The Richter (2000) and Naidoo, et al. (2003) studies provide us with the information about the refractive status to expect in the mentioned age groups which is vital in the current study.

3.2.3 Accommodation

Rutstein (1998), Rowe (1997) and Borish (1970) define accommodation as the ability of the intraocular lens to increase its convexity, altering the eye's dioptric power and thus enabling light diverging from a near source to be focused upon the retina in order to obtain a clear image. Scheiman and Wick (2002) stated that a complete evaluation of the accommodative system should include the amplitude, accuracy and facility. Efficient accommodation allows for clear and comfortable vision during prolonged near work, such as reading.

The following discussion includes studies that investigated the prevalence of accommodation infacility, and inaccuracy or low amplitude amongst children. The studies to be discussed in this section investigated the different aspects of accommodation separately. However in this study the three components of accommodation were investigated simultaneously on each child.

Hoffman (1980) measured the amplitude of accommodation using the minus lens and push-up method, and accommodation facility using ± 2.50D lenses on 107 learning disabled children, aged between 5 - 14 years. These were children reported by educators, school and private psychologists as well as reading specialists to have learning problems. The results of tests on the learning disabled children were compared to the results of a control group of 25 children of the same age referred to the clinic primarily for visual care and not learning disabilities.

Hoffman's (1980) study showed a higher prevalence (83%, 64%) of accommodation infacility and lower amplitude of accommodation respectively in the learning disabled group. In the control group the prevalence of accommodation infacility was found to be (44%) less than in the learning disabled group. The amplitude of accommodation in children with no learning problems was not evaluated due to time constraints. The fact that the comparison group itself was selected from a purposive population of children referred to a general optometry clinic, and since their reading ability was not assessed at the time, necessitates further study to determine more objective prevalence of accommodation infacility in both groups with or without learning disabilities.

Scheiman and Herzberg (1988) stated that Hoffman's (1980) study based its interpretation of the data on adult accommodative facility parameters. According to Scheiman and Herzberg (1988); Hoffman (1980) used ± 2.50D lenses instead of the ± 2.00D lenses generally used with children. He further stated that the failure criteria of not achieving 15-20 cycles per minute (cpm), monocularly or binocularly seems to be unrealistically high as a guide to judge normal versus abnormal accommodative facility especially in children. It is recognized that the published normative data concerning accommodative facility in school-aged children was not available at the time of the study. The other problem with Hoffman's (1980) study was that variables such as suppression for binocular testing were not controlled and thus erroneous assessment of the subject's performance could have influenced the results. However, the results of this early study indicate that children with learning problems may have a higher prevalence of accommodation infacility.

Burge's (1979) (in Zellers, 1984) in an attempt to verify the importance of monitoring suppression during binocular accommodative rock performed a study on 30 subjects 6 - 30 years old. The subjects screened were nonstrabismic, correctable to 6/6 monocularly and binocularly. In this case the accommodative facility was evaluated using the Spirangle Vectogram, cross-polarizing viewers and +/-2.00D lens flippers. The results with and without the Polaroid viewers were 9.5cpm and 7.0cpm respectively. Without the Polaroids the accommodative facility was found to be higher than with the Polaroids, due to the fact that without Polaroids suppression was not monitored. Burge (1979) (in Zellers, 1984) thus concluded that for the maintenance of good functional binocularity at nearpoint it is essential that suppression be monitored during binocular accommodative facility testing.

The prevalence of accommodation facility was also investigated by Rosner and Rosner (1987). The study found that there was almost the same prevalence 9% and 10% of accommodation infacility in children with and without learning disabilities, respectively. This study found no significant differences between the normal readers and children with reading disabilities, even though the study looked at accommodation facility only. The interpretation of the study findings cannot be relied upon since the norms and the methods used to evaluate accommodation facility in the two groups were not mentioned in the study.

The following discussion is about the relationship of accommodation skills to reading performance. A link between these two variables would contribute towards an understanding of the role of visual disorders in learning disabilities

Poytner, Schor, Haynes and Hirsch (1982) conducted a study involving 42 fourth graders and 32 sixth graders from a normal school (mainstream), to determine the oculomotor function in reading disability. Poytner and his colleagues (1982) also investigated the accuracy of the accommodative response when reading. The children read texts at their own reading grade level, and in order to control for language ability the Stanford Achievement Test Reading Comprehension subtest was performed with the subjects reading prose and digits. In addition, the Peabody Picture Vocabulary Test was used to assess verbal intelligence. The lag of accommodation was measured using the monocular estimate method (MEM) retinoscopy during the prose and digit reading.

A negative coefficiency (-0.20 to -0.28 for the 4th graders and -0.13 to -0.20 for the 6th graders) between reading and lag of accommodation for both age groups under the prose and the digit-reading conditions was found, with and without controls for verbal intelligence. Thus concluding that in the presence of a high lag of accommodation poor reading performance was detected.

Poytner, et al.'s (1982) study also found a difference of 6% - 8% in the reading ability for the two age levels. Even though the size of the relation between lag of accommodation and reading ability was small, a conclusion was reached that the lag of accommodation appeared to be an indicator of reading ability in both age groups.

Kulp and Schmidt (1996a) did a comprehensive study investigating the relationship between various visual skills (including uncorrected refractive error, phoria/ vergence relation, visual acuity, Randot stereopsis, +/-2.00D flipper lenses with red/green suppression check for accommodation facility and visual analysis skills) and reading performance. The study was conducted on 90 kindergartners (mean age 5.73 years and 91 first graders (mean age 6.76 years) from a normal school. The study revealed that accommodation facility was predictive of successful reading performance in 7-year olds and first graders, since the mean accommodative facility was found to improve with age. Accommodation facility was found to have improved greatly between the ages of 5- (mean 3.2) and 7-year old (mean 3.56) groups (see Table 2.1 below).

Table 2.1: Means of accommodative facility

	5 years		**6 years**		**7 years**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Accommodative Facility (cycles/30secs)	3.2	1.94	3.43	1.56	3.56	1.36

A relationship between accommodation difficulties and performance in nearpoint tasks, such as reading was found, even though the above mentioned studies were done to investigate the different facets of accommodation skills, for example facility, amplitude or accuracy (lag) independently. This study therefore evaluated the collective effect of accommodation skills on reading performance.

3.2.4 Vergence system

Leat, et al. (1999) and Borish (1970) define vergence eye movements as disjunctive movements occurring when fixation is changed from a distant to a closer object or vice versa. The vergence system depends on tonic innervation to the extra ocular muscles, accommodation and perceived distance of the object of interest, enabling the visual axes to converge for the image of the object of interest to be maintained on the fovea of each eye.

Griffin (1992) stated that in fully evaluating the vergence system it is important that absolute and relative convergences are evaluated. The three important components of absolute convergence that are assessed should include the amplitude, facility, and stamina, which can be assessed using the near point of convergence test. Griffin (1992) further suggested that relative vergence refered to the stimulus initiated by retinal disparity measured from the ortho demand point without involving the effects of tonic, accommodative and proximal vergence (Borish, 1970).

Jimenez, Perez, Garcia and Gonzalez (2004), proposed that for a complete evaluation of the vergence system, the visual parameters used to characterize the vergence system should include, near and far horizontal and vertical phorias, near and far negative and positive fusional vergence (amplitude), vergence facility and near point of convergence.

Griffin (1992), stated that having a normal fusion amplitude does not rule out the dysfunction of the fusional vergence. According to him the other characteristics of the vergence system including poor vergence facility, and reduced near point of convergence could also contribute to vergence dysfunction. Scheiman and Wick (2002) in agreement with Griffin (1992a), stated that in fully evaluating the vergence system in the presence of the normal fusion amplitudes it is important to conduct the additional tests of the vergence facility and near point of convergence.

Thus this study evaluated the different aspects of the vergence system including the facility, amplitude and the near point of convergence, which will be discussed in this section.

The following discussion will focus on studies done on children with learning disabilities regarding the prevalence and the role of vergence problems. Suchoff (1981), in his literature review about the relationship between reading and vision, questioned the importance of the distance phorias with regard to reading, and concluded that its role is not clear. To the contrary Grisham and Simons (1987) in their literature review based on the findings from several studies (Robinson, 1946; Fendrick, 1935 and Eames, 1932a) concluded that poor reading performance is associated with near excessive fixation disparity, hyperphoria and convergence insufficiency.

Simons and Grisham (1987), referred to heterophoria as the latent deviation requiring fusional vergence to maintain single binocular vision. They thus concluded that the smooth functioning of the fusional vergences especially at near is important for the near task of reading. Several other studies, Eames (1935b, 1948); Good (1938) quoted in Simons and Grisham's (1987) literature review, found a higher prevalence of lower convergence reserves, exophoria and esophoria with lower fusional reserves at near in children with reading disabilities compared to children without reading disability.

Garzia (in Scheiman & Rouse, 1994) cited investigations (Stein, Riddel & Fowler, 1988; Hung, 1989), which supported the notion that the reading disabled has disordered vergence. These studies compared vergence eye movements (Stein, et al. 1988; Hung, 1989) and vergence facility (Buzelli, 1986) of children with and without reading disabilities, using both clinical and laboratory tests. The reading disabled were found to exhibit disordered vergence eye movements, whereby rather than making disjunctive eye movements when reading they responded with conjugate eye movements. Significantly slower vergence facility of the reading disabled compared to a control group was found with 16PD base-out and 4PD base-in (Buzelli, 1986).

Marcus (1974) evaluated visual skills efficiency of 60 learning disabled children with ages ranging from 6 - 16 years. The tests performed to evaluate binocular vision included the nearpoint of convergence, measurements of the positive and negative fusional reserves for both distance and near vision using a 5-point scoring system. A total score of 60-points was used to calculate a percentage score of binocular efficiency.

Marcus (1974) study revealed that, 98% of the children tested had less than 15PD with base out (BO) to recovery at near, and 95% had less than 21PD with BO to break at near. 83% scored less than expected (>5PD) with BO to break, and 93% scored less than expected (>10PD) to recovery at distance. Regarding BI to break and recovery at near 93% and 95% scored less than expected respectively. 73% and 87% scored less than expected with BI to break and recovery at distance respectively. 60% were found to have inadequate near point of convergence (less than 8/10cm for break and recovery respectively). These findings revealed a high prevalence of reduced positive and negative fusional vergences at distance and near, with more than 50% of the subjects exhibiting convergence insufficiency. Marcus thus concluded that a learning disabled child approaches the learning task with a visual system that requires great effort because of its existing functional inefficiencies, and thus contributing to poor academic effort.

O'Grady (1984) in his study evaluated the vergence system using the near point of convergence test and cover test at both distance and near. The sample was composed of 300 children, aged 7 years old and randomly selected from 74 schools in Tasmania. Convergence ability was categorized as normal (10cm), border-line (10 - 13cm) and suspect 13cm. Ninety percent of these children exhibited normal nearpoint of convergence, 5% borderline and 5% suspicious near point of convergence. In the children who were identified as having borderline/suspect near point of convergence a high prevalence of reading inaccuracy was found, even though the statistical analysis of the results was not provided in the study. It was therefore concluded that convergence insufficiency is a contributing factor towards reading inaccuracy since their relationship was found to be significant at the 5% level. Due to differences in opinions about the cut-off points regarding expected norms for the cover test, it was considered inappropriate to categorize the cover test results. In conclusion the study convinced the Tasmanian Education Department that a receded nearpoint of convergence (13cm and more) adversely affected children's educational performance.

A common finding of the mentioned studies revealed a high prevalence of high exophoria and a receded near point of convergence for the poor readers (Eames, 1934, 1948; Marcus, 1974 & O'Grady, 1984).

3.2.5 Ocular motilities

A discussion of the basic aspects of a normal reading eye movement pattern compared to eye movement patterns of children with reading disabilities will assist the researcher in investigating the relationship between visual disorders and learning disabilities.

Ciuffreda and Tannen (1995) stated that when reading the ocular motilities play a major role for the continuing acquisition and updating of visually presented information. The eye movements are divided into two basic categories which are pursuits and saccades. Ciuffreda and Tannen (1995) further concluded that pursuit eye movements are the following eye movements that ensure constant target foveation, thus allowing maximum resolution, information gathering and processing of fine details of a moving object. Garzia (in Scheiman & Rouse, 1994) also stated that the evaluation of pursuit eye movements in the reading disabled is important, since they reflect the attentional capability of the person.

Stark (in Ygge & Lennerstrand, 1994), and Griffin, et al. (1997), described the pursuit and saccadic eye movements as accurate, rapid eye movements used when reading, requiring a fixation pause each time an object of interest is focused on the retina. They further described the normal saccadic eye movements during the process of reading as consisting of the fixational pauses referred to as duration of fixation, the forward saccadic eye movements (left-to-right), and the larger leftward saccadic movements, directed from right-to-left. In addition to that Grisham and Simons (in Rosenbloom & Morgan, 1990) also stated that regressions are usually followed by smaller corrective saccades to readjust the eye position to the beginning of the next line. Grisham and Simons (in Rosenbloom & Morgan, 1990) further suggested that smaller vergence, and general head and body movements occur during the process of reading activating the vestibular ocular reflex. Kulp and Schmidt (1996b) in their literature review proposed that accurate eye movements and continuous integration of the information obtained from each fixation by the brain is required for efficient reading.

Ciuffreda and Tannen (1995), Ygge and Lennerstrand (1994), Griffin, et al. (1997) and Eden, Stein, Wood and Wood (1995) additionally supported the hypothesis that other factors such as perceptual span, reading rate and the integration across the saccade also affects reading efficiency. Griffin, et al. (1997); Rayner (in Ygge & Lennestrand, 1994) and Park and Burri (1943) (in Scheiman & Rouse, 1994), further emphasized that the eye movements of poor readers (or when text is difficult to decipher in normal cases) are characterized by increased fixation duration, increased forward saccade reduced in length and increased regressions.

A study done by Poytner, et al. (1982) further supported the fact that efficient reading is due to a complex interaction of oculomotor functions and information processing systems. Poytner's, et al. (1982) study revealed that collective oculomotor dysfunctions (decreased forward saccades length, increased regressions, increased fixation duration and lag of accommodation) are related to poor reading performance (r = 0.20 to .45), but not when independently evaluated. Poytner, et al. (1982) further stated that when the individual oculomotor functions are independently evaluated, only marginal significant relations were revealed in 6 - 8% of cases; whilst relationships were influenced partly by verbal intelligence measured using the Peabody picture vocabulary test score. Fixation frequency and lag of accommodation were found to have the strongest influence in the collective relational analysis.

Marcus (1974) in his study also evaluated ocular motilities including the saccadics and pursuits in both the horizontal and vertical meridians using the direct observation method. Sixty eight percent of these children did not have smooth and effortless pursuit eye movements in both the vertical and the horizontal meridians. In evaluating saccadic and pursuit eye movements, 62% and 68% exhibited inefficient ocular motilities respectively in all meridians. He thus concluded that there is a high prevalence of oculomotor dysfunctions in children with learning problems.

Chernick (1978) visually screened 80 poor readers 8 - 11years old, identified as children reading at a level 2 or more years below grade level, using the Stanford Achievement Tests. He also evaluated ocular motilities including pursuits and saccadics using the direct observation method and the criteria for failure was the undershooting, overshooting, fixation loss, or head movements. Seventy nine percent of these children failed either the pursuit or the saccadic eye movements thereby indicating a higher prevalence of inefficient ocular motilities than in any of the visual skills evaluated including accommodation, fusion, visual acuities and refractive errors.

Hoffman (1980) in agreement with Chernick (1978) and Marcus (1974), performed a study in which he measured oculomotor efficiency using the direct observation method. Hoffman's (1980) study was done on children (n = 132) referred to the paediatric eye clinic aged 5 - 14 years, of which 107 had learning disabilities and 25 children had no learning disabilities. About 94% of children with and 24% of children without learning disabilities had oculomotor inefficiencies respectively. This study provided more evidence that the prevalence of oculomotor inefficiencies in children with learning disabilities is higher than in children without learning disabilities.

Assessment of oculomotor functions involves the evaluation of the stability of fixation, saccadic and pursuit function. There are several objective tests that can be used to evaluate ocular motilities for example the Pierce Saccade, Developmental Eye Movement (DEM), and the King-Devick tests which according to Scheiman and Wick (2002) are designed to measure according to similar principles. Rouse, Nestor and Parot (1991) (in Scheiman & Wick, 2002) in their study on 30 third graders used the DEM test on the subjects and retested them a week later. A low correlation for the DEM ratio score was found, thus leading to the questioning of the test re-tests reliability of the test.

The North-Eastern State University College of Optometry (NSUCO) oculomotor test, according to Scheiman and Wick (2002), is recognized as the 1st standardized direct observation test to have been developed. According to Maples (1995) (in Scheiman & Wick, 2002) the test was found to be both reliable and repeatable. The NSUCO test consists of a standardized instructional test, description of appropriate targets, instructions on target placement, a standardized scoring system, and normative data. The latter test appears to be of greater value for the examination of oculomotor functions.

It appears as if the most significant relationship between vision disabilities and learning disabilities so far have been found in the area of oculomotor functions. For purposes of this study the assessment of these functions would be of importance.

3.2.6 Ocular health status

It is essential that ocular pathology should be excluded in all cases of reading disability. Rosenbloom and Morgan (1990) stated that a complete ocular health evaluation should include the external and internal examination of the eyes. The internal examination includes the anterior and the posterior segment to ensure normal growth, health, development and functional status of the ocular structures.

Faye (1984) (in Rosenbloom & Morgan, 1990) mentioned studies from 1979 – 1983 which investigated the ocular health status of persons 19 years and younger. Optic atrophy, followed by cataracts, albinism and myopia were found to be the leading cause of visual disorders in the mentioned age group. Chernick (1978) in his study evaluated ocular health using the ophthalmoscopy and found no significant prevalence of ocular pathology in children with learning disabilities. Rosner and Rosner (1987) in their retrospective study also compared the ocular health status of children with and without learning disabilities. The prevalence of ocular pathology in the children with no learning problems and in those with learning problems 13% and 10%, respectively was found to be not significantly different .

Although poor ocular health contributes to the child's poor visual acuities leading to low vision, poor ocular motilities, accommodation insufficiency and a deficient vergence system, no significant differences in the prevalence of active ocular pathology in children with and without learning disabilities was found.

3.3 CONCLUSION

Supporting evidence that visual functions adversely affect learning performance has been discussed. An analysis of the literature on the subject indicates that the vision deficiencies including, poor near visual acuity, hyperopia and significant anisometropia, exophoria or esophoria at near, poor fusional vergences at near, accommodation dysfunctions and poor ocular motilities have been found to impinge on the learning process of individuals. Since learning disability is a heterogeneous disorder other factors such as language facility, attention disorders perceptual disorders, social backgrounds have also been found to have different effects on how the visual profile affects the learning performance. Specifics of the learning problems are important to guide the testing to be done, and also to make sense of the data collected.

The subsequent chapter will explain the design and methods used to evaluate visual skills affecting the learning process. The visual skills evaluated will be according to Scheiman and Wick's (2002) model of vision, but will exclude the information processing skills due to the time constraint encountered when performing the current study.

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CHAPTER 4

RESEARCH DESIGN AND METHODOLOGY

4.1 INTRODUCTION

The literature review on learning disabilities in Chapter 2 revealed that learning disabilities are associated with a cluster of disorders, including attention disorders, failure to develop and mobilize cognitive strategies for learning, poor motor abilities, perceptual information processing problems, oral language difficulties, written language difficulties, mathematics difficulties and inappropriate social behaviour. The cluster of the disorders mentioned contributes towards the definition of learning disabilities not being clear and leads to problems in the diagnosis of children with learning disabilities. The other important aspect of this definition is its exclusionary part whereby it states that individuals with learning problems could also be having hearing, visual, psychological and mental disorders but it must be borne in mind that these disorders are not the primary source of learning disabilities.

In this chapter the design of the study will be discussed, the sampling criteria, the selection criteria, data collection and the tests performed on the respondents to collect data. The expected norms will also be discussed, as well as the statistical analysis method used.

4.2 STUDY DESIGN

This study is a cross-sectional survey and it is also referred to as a correlation study. According to Hatch (1998) the correlation study is a commonly used method on clinical tests and tends to compare or correlate data at one point in time. Hatch (1998) further stated that this type of study is quick, efficient, easy and inexpensive, with its disadvantage being the restricted time component.

Another disadvantage is that it has been found to lead to speculation regarding cause and effect once the relationship between exposure and disease is identified.

Gehlbach (1993) (in Hatch, 1998) stated that the cross-sectional design is also excellent for assessing diagnostic tests. In the case of when more subjects with learning disabilities test positive than controls, then the study can determine which visual tests can be done to identify children with learning disabilities. This study was designed to answer a clinical question concerning whether children with learning problems have more visual deficiencies than children from the mainstream school, thus the cross-sectional survey design was used for this study.

4.3 SAMPLING AND SAMPLING STRATEGY

Purposive sampling was used to select the subjects (respondents) participating in the study. De Vos, et al. (1998) stated that this type of sampling is useful in studies where research subjects are selected who contain the most characteristics of a population and are therefore representative of that population with typical attributes.

The sample was selected at two different locations; a mainstream school and two schools specializing in the education of children with learning disabilities. The mainstream school was selected purposively because of its proximity and due to the fact that it is representative of the "average" school in Johannesburg. All children in grades 3 and 4 from the mainstream and the school of the learning disabled were selected to participate in this study. According to the observations of Flax (in Scheiman & Rouse, 1994), children with learning disabilities are identified when their reading is well below grade level, and is generally identified during the 3rd or 4th grade since this is when the child acquires reading ability and any lags become identifiable by comparison to norms.

4.4 SELECTION CRITERIA

All the children in grade 3 and 4 were purposively selected to participate in the study. No specific criteria for both the respondents from the mainstream and the learning disabled schools was used. From the learning disabled schools consent was given by all the parents for their children (N = 112) to participate in the study, and from the mainstream school only two parents did not give consent for their children in grade three (3). Therefore from the mainstream school with the two classes combined (grade 3 and 4) only 80 children participated in the study from the class of 82 learners. From both schools 192 subjects from grade 3 and 4 with their ages ranging from 8 to 13 years participated in the study.

4.5 DATA COLLECTION

The research record card designed by the principal investigator for the recording of the functional visual skills evaluated was used to collect the data (See Annexure A). The class lists were furnished to the researcher with the names, ages and gender of the respondents and this information was filled in the record card by the researcher herself before the visual evaluations. The visual evaluations were done under the supervision of the principal investigator together with the 18 fourth year optometry students from the University of Johannesburg. The field workers were orientated beforehand through a workshop conducted by the researcher on the techniques to evaluate the visual skills (emphasis was on the targets used, methods, time factor, postures and illumination).

The visual evaluations were done in the morning from 9:00 until 11:30, with each child evaluated for approximately 25 minutes. The respondents were evaluated in pairs with 5 different stations set up for measuring visual acuities, retinoscopy (static and dynamic), ocular motilities, accommodation (facility and amplitude), cover test with near point of convergence, smooth vergences, vergence facility and ocular health. Children who were evaluated were kept in a separate room that was made available by the targeted schools.

4.6 ETHICAL CLEARENCE

The project proposal was approved by the committee for Academic Ethics at Rand Afrikaans Universiteit (RAU) (currently The University of Johannesburg). This provided the necessary permission for the researcher to apply to the Gauteng Department of Education for permission to approach the targeted schools. Approval was granted to the researcher by the Gauteng Department of Education to conduct the research in the schools under their jurisdiction. A consent form was sent to the parents of children selected (all the Grade 3's & 4's) to participate in the study (See Annexure B). This was done to ensure that respondents had a choice to participate in the study. Learners whose parents did not want them to participate in the study were not included in the study.

4.7 EXPERIMENTAL METHODS: VISUAL SKILLS EVALUATIONS

Functional visual skills screened included visual acuities at distance (6m) and near (40cm), refractive status, accommodative status, vergence system, ocular motilities and ocular health status (Scheiman & Wick, 2002). The evaluation of the visual skills was in the form of screening, which is an accepted technique for identifying conditions that may impede the process of learning. All the tests were conducted without any spectacle correction, i.e. neither the habitual prescription nor the final best corrected spectacle prescription.

Rosenbloom and Morgan (1990) stated that for detecting amblyopia and significant refractive error, the Snellen letter acuity test can be used with the other tests and not on its own. Even though it is an inexpensive and quick test it is not effective for evaluating binocular vision. Blum, et al. (1959) (in Rosenbloom & Morgan 1990) were quoted as having, conducted the Orinda study on 1920 children aged 6 to 13 years with no pathologic conditions. Rosenbloom and Morgan (1990) stated that in their study the relationship between the refractive status and visual acuity was found to be complicated. Due to the fact that subjects who exhibited uncorrected refractive errors of +4.00 with -1.00D cylinder were still able to read 20/30 letters on the Snellen chart. Subsequently the Orinda study established the Modified Clinical Technique (MCT) composed of a series of highly effective series of tests for procedures used on school-aged children, which also included the visual acuity tests. A panel of Optometrists from the faculty of the University of California, Berkely, School of Optometry and ophthalmologists from the faculty of Stanford (California) University School of Medicine agreed upon the procedures and pass-fail criteria for the visual screening procedures suggested in the Orinda study.

There are various methods of visual screening mentioned in Rosenbloom and Morgan(1990) from 1944 to 1959, which included visual acuity testing alone, Telebinocular, Photo refraction, Ortho-rater, Modified Clinical Techniques. Rosenbloom and Morgan (1990) stated that reliability and validity of the procedures used for the visual screening were essential. Whereby reliability referred to the consistency, with validity referring to the sensitivity and specificity of the screening procedures.

The following discussion will be about the methods used to evaluate the above mentioned skills and the norms expected. The discussion will be based on the recent studies mentioned and the norms which will incorporate some of the above mentioned screening procedures and criteria.

4.7.1 Visual Acuities

A Snellen letter acuity chart was used to assess visual acuity at distance (6m) and near (40cm). This method was found to be appropriate for evaluating children of school going age, since they are at grade levels where they are reading to learn and not learning to read (Press, 1993). Rosenbloom and Morgan (1990) also stated that the skill of consistently naming the individual letters is mastered around the age of 5 years, and can be learned at a younger age when the child is approximately 3 years of age. Thus the respondents were expected to be familiar with the letters.

The visual acuities were evaluated monocularly and binocularly. In the current study the passing criteria for visual acuities was 6/9 or better since the subjects involved in this study were older than 7 years. Schmidt (1986) (in Rosenbloom & Morgan, 1990), Lovie-Kitchin (in Leat, et al. 1999) stated that using the Snellen acuity chart, acuity must differ by at least two lines for differences in acuity between the two eyes to be regarded as significant.

4.7.2 Refractive status (retinoscopy)

Static retinoscopy was performed to objectively determine the refractive status. This test was performed at 40cm, with a +2.50 lens added to relax accommodation at the test distance. A retinoscopic light was shined into the subject's eyes, with the child instructed to fixate a 6/60 target at distance. Hyperopia of less than 1.00D was accepted as normal; anisometropia of more than 1.00D was regarded as abnormal. Astigmatism of more than 1.25DC and myopia exceeding 2.00D was regarded as abnormal (Moore, 1997). Moore's criteria as mentioned in the above paragraph was preferred based on the fact that it is recent and specific.

4.7.3 Accommodation evaluation

The following discussion will describe the different methods used to evaluate the three components of accommodation including the amplitude, facility and response (accuracy).

4.7.3.1 Accommodation accuracy: (Monocular Estimation Method (MEM) Retinoscopy)

MEM retinoscopy was used to objectively evaluate the accuracy of the accommodative response (lag or lead). Rouse (1982) (in Rosenbloom & Morgan, 1990) stated that MEM has shown to be a valid and reliable method for measuring accommodative response. The test was performed in normal room illumination since according to Scheiman and Wick (2002) dim illumination alters the accommodative response. The test was performed without the final or habitual prescription using retinoscopy, under binocular viewing conditions at Harmon's distance (distance from the child's elbow to the middle knuckle). The child was instructed to read the letters on the MEM card depending on their grade level where the examiner determined the direction of the reflex with the retinoscope. Lenses were interposed briefly to determine if the child had a lag or lead of accommodation. The expected value according to Scheiman and Wick (2002) of the lag is from +0.25 to +0.50D with a standard deviation of ± 0.25D, a lag below plano or greater than +0.75D suggested a strong (lead) or weak accommodation response respectively.

4.7.3.2 Accommodation facility

The ability of the accommodative system to change focus from one level to another was objectively assessed monocularly and binocularly using the ± 2.00D flipper lenses. The children were given targets that required good focus (6/9 letters) at 40cm while the lens power was changed from plus to minus and each eye was evaluated for 1 minute. The target used was the Bernell Vectogram Acuity/Suppression slide (#SO/V9). Polaroid lenses were worn only during binocular and not the monocular part of this test, to monitor for suppression. With the Polaroid glasses only the right eye could see the letters in row number four (4) and the left eye could see the letters in row number six (6). The letters in row number five (5) were seen by both eyes, but due to time constraints the binocular accommodation facility could not be assessed in all the respondents.

The children were expected to read at the most three letters in row 4 and 6 for the right and left eye and row number 5 for binocular testing, aloud as quickly as possible. With the introduction of each lens flip the actual number of completed cycles in one minute was recorded for both monocular and binocular testing. The clear response was recorded when the subject successfully called off the three letters in row number five. According to Zellers, Alpert and Rouse (1984), Press (1993), and Scheiman and Wick (2002) the facility of accommodation was regarded as normal for the age group (8 – 12 years) monocularly should they achieve 7 cycles per minute (cpm) with a standard deviation of ±2cpm and binocularly if they achieve 5cpm with the standard deviation of ±2cpm. Children without accommodation infacility were regarded as having failed the test.

4.7.3.3 Amplitude of accommodation

Borish (1970) stated that the maximum amount of accommodation the eye is capable of, is represented by the amplitude of accommodation.

The amplitude of accommodation was determined monocularly and binocularly using the push-up method, with the final prescription using the retinoscope. It was measured with a small target print size equivalent to 6/9. The target was slowly brought closer to the uncovered eye until the first sustained blur was reported. At the distance where the first blur was reported a measurement was taken using the ruler to determine the amplitude. The accommodative amplitude was measured in centimetres and then converted to dioptres (Scheiman and Wick, 2002).

Based on Duane (1908) (in Rosenbloom & Morgan, 1990) the expected maximum and minimum amplitudes of accommodation for a child of a given age were determined using Hofstetter's (1950) (in Rosenbloom & Morgan, 1990) formulas.

Expected amplitude (D) = 18.5 - 0.3 (age in yrs)
Maximum amplitude (D) = 25 - 0.4 (age in yrs)
Minimum amplitude (D) = 15 - 0.25 (age in yrs)

The amplitude of accommodation was categorized according to 5 ranks (see Table 4.1 below) based on the minimum requirement as it is according to Hofstetter's (1950) formulas.

Table 4.1: Ranking of Accommodative Amplitude

Rank	Amplitude
5 Very Strong	1.00 D or more above average
4 Strong	0.50 D above average
3 Adequate	Average for age
2 Weak	2.00D below average
1 Very Weak	4.00D or more below average

If the amplitude was 1.00D or more above age average, it was regarded as strong and ranked number 5, an amplitude of 4.00 or more below age average, was regarded as very weak and ranked number 1 (Griffin, et al. 1992). According to Scheiman and Wick (2002) a decrease of the amplitude of accommodation with repeated measurements indicates ill-sustained accommodation. A difference of amplitude of accommodation more than 2.00D between the two eyes was regarded as ill-sustained.

4.7.4 Vergence system evaluation

The following discussion will explain the different methods used to evaluate the different components (amplitude, facility and sufficiency) of the vergence system.

4.7.4.1 Cover test

Moore (1997) stated that the Cover Test is an ideal method for detecting as well as quantifying strabismus, and obtaining information related to the frequency, direction, and laterality of the deviation. This test was performed as unilateral and alternating cover tests, administered to investigate if the child had a manifest (strabismus) or latent (heterophoria) deviation. The cover test was also performed with the prism bar to estimate the magnitude of the deviation. At near a target with fine detail was used for the maintenance of the child's accommodation accuracy and to help maintain the child's attention. At distance an isolated letter one line larger than the best visual acuity was used. Rosenbloom and Morgan (1990) suggested the utilization of mobile targets if the child was inattentive. Scheiman and Wick (2002) proposed that to sensitize the test, a pursuit eye movement test can be done with the cover test at near especially if the child was inattentive to the target.

In the current study the test was done at near (40cm) and at far (6m) using the same targets according to Moore (1997). Unilateral and alternate cover tests were performed with children instructed to fixate the target and keeping it clear throughout testing. Objectively the magnitude of the deviation was estimated with the prism bar to neutralize the eye movements using the alternate cover test. The phi phenomenon (with the subjects mentioning the direction of the movement of the target fixated with respect to the occluder) was utilized when the eye movements were not apparent (less than 2 prism diopters) when doing the alternating cover test (Scheiman and Wick, 2002).

Scheiman and Wick (2002) expects normal findings for the 3rd and 4th graders to be the same as that for adults since no change in the phoria with age has been noted (Jimenez, et al. 2004). The expected normal findings were as follows:

1 prism diopter exophoria at distance (6m) with a standard deviation of +/-2 prism diopters; 3 exophoria at near (40cm) with a standard deviation of +/- 3 prism diopter (Scheiman and Wick, 2002).

4.7.4.2 Nearpoint of convergence

The purpose of this test was to evaluate the amplitude of convergence. The respondent was instructed to fixate on a detailed accommodation-stimulating target, such as an isolated 6/15 letter. This test was performed with the respondents not wearing the spectacle prescription. The evaluation was done objectively (the examiner detects a break in fusion) as well as subjectively (the respondent announces seeing double) with the target moved towards the respondent's spectacle plane. The distance was noted as the breakpoint (when they see double), and the target was moved away from the respondent until a single target was reported, and that was recorded as the recovery point. The distances were measured using the pupillary distance (PD) ruler. If the near point of convergence (break point) was greater than 7cm the test was then repeated using the penlight as the target and the red lens in front of the right eye, to confirm if the respondent had a convergence or an accommodative problem (Scheiman and Wick, 2002).

Jimenez, et al.'s (2004) study on 1015 subjects ages 6 to 12 years old concluded that there were no clinically meaningful differences of the NPC between the ages, and thus age has no effect on the NPC. In agreement with Scheiman and Wick (2002) the expected findings were the same as that of adults. The measurement for break was 5cm, with the standard deviation of ±2.5cm, with a recovery of 7cm and standard deviation of ±3.00cm. A break point greater than 8cm with the recovery more than 10cm was considered abnormal. With the red lens a greater recession more than 7cm for break and more than 10cm for recovery suggested a significant convergence problem.

4.7.4.3 Smooth vergence

The fusional vergence amplitudes were tested objectively using a fixation stick with an isolated letter 6/9 held at 40cm. Respondents were instructed to keep the letter single at all times while a prism bar was interposed as respondents attempted to keep the target clear and single. The procedure began with a base-in prism in front of the right eye whilst the other eye was open, and increased by approximately 2 prism diopters (PD) per second until the respondents reported seeing double.

The test was also performed objectively by the examiner observing the respondent's eyes, to note when the child loses binocularity. The prism power was then decreased until the respondent reported seeing single, and the vergence amplitude was then evaluated using the base-in (BI) and the base-out (BO) prisms. The positive fusional vergence amplitude was considered very weak if the respondent reported a break with less than 15PD (BO), and recovery to singleness with break less than 10PD (BO) at near. The negative fusional vergence amplitudes for break of less than 7PD (BI) and recovery of less than 3PD (BI) at near were regarded as abnormal for the respondents in grades 3 and 4 (Scheiman & Rouse, 1994). Press (1993) stated that the blur response is very difficult to obtain in young children, thus in this study it was expected that most children will not report seeing blur.

According to the literature review of this study poor near fusional vergences were found to impinge on reading performance and, thus amplitudes were tested at near only.

4.7.4.4 Vergence facility

Vergence facility subjectively evaluates the ability to make rapid and repetitive vergence changes (facility) over an extended period of time (sustainability). The test was performed at near (40cm), with respondents presented with a vertical row of small but legible letters (6/9), with the 8PD (BI) and 8PD(BO) mounted in a flipper device.

Jimenez, et al. (2004) stated that most researchers (Stueckle & Rouse, 1979; Atkinson, Moser & Rouse, 1980; Mitchel, Stanich & Rouse, 1980) use the 8PD (BI)/8PD (BO) as opposed to 4PD (BI)/16PD (BO) (Buzelli, 1986; Scheiman & Herzberg, 1988). With the flipper prisms in front of the eyes, respondents were instructed that initially the letters will be double. Respondents were then instructed to try and make the letters single and clear, and to report that to the examiner. The number of cycles completed per minute was then recorded as the facility of the vergence system.

The mean expected value from other studies (Atkinson, et al. 1980) was found to be 6.5cpm with a standard deviation (SD) of ±4.0 for the age group of 9 to 12 years. This expected mean value for the same age group 9 to 12 years was found to be higher than that in a recent study of Jimenez, et al. (2004) (of 4.5cpm with SD of ±2.3), due to the fact that in this study suppression was monitored unlike in the study by Jimenez, et al. (2004).

For the purpose of this study the expected norms considered were those according to Atkinson, et al. (1980) studies (in Jimenez, et al. 2004) as mentioned in the above paragraph, since suppression in this study was not monitored.

4.7.5 Ocular motilities

In the literature review it was mentioned that ocular motilities also play a role in the process of reading. The following discussion will be on the evaluation methods used to investigate ocular motilities. The ocular motilities evaluated were the fixation maintenance ability, pursuits, and saccadic eye movements. Judgment of the three ocular motor abilities was determined qualitatively using the direct observation method. The standardized direct observation test, using the North-eastern State University College of Optometry (NSUCO) was used to evaluate saccadic and pursuit eye movements, since it has shown to be reliable and repeatable (Maples, 1995; in Scheiman & Wick, 2002). For fixation maintenance the California College of Optometry (SCCO) (Griffin, 1992) scoring criteria was used, since it was regarded to be a quick and easy test for position maintenance

(Hoffman, 1980). The targets used for the testing of the ocular motilities was approximately the size of a 6/24 letter E or a red circular sticker on the Gulden fixation stick according to Griffin (1992); and Scheiman and Wick (2002) respectively. The targets used were big enough due to the fact that when evaluating the ocular motilities the respondent did not need accommodation to perform the task accurately and efficiently. The ocular motilities were performed with the respondent standing directly in front of the examiner, since posture is important in the execution of proper ocular motilities.

4.7.5.1 Fixation maintenance

The ability of the respondent to maintain steady fixation on a fixated object was evaluated, since this is important in the process of reading as mentioned in the literature review. Position maintenance was assessed by asking the respondent to fixate monocularly on a target at a distance of 40cm. Griffin (1992) stated that during fixation the eyes are not motionless, and that there are micro eye movements with rapid and slow drift flicks of small amplitudes which are not observable with direct observation but with special equipment.

Gay, et al. (1974) (in Griffin, 1992) further stated that the small movements are to keep the fixated target on the fovea to prevent retinal fatigue. The respondents were expected to maintain a steady fixation with no noticeable drifting of the eyes from the fixated target. Griffin (1992) suggested that if there is a problem with the patient maintaining steady fixation, he/she is to be instructed to hold his/her thumb at 40cm to determine if the proprioceptive input from the hand support is of help in maintaining steady eye positioning.

The criteria to evaluate this skill were based on the 5-point scale of Southern California College of Optometry (SCCO) system (in Griffin, 1992). Table 4.2 below shows that (1) is very weak, indicating that the subject has unsteady fixation almost continuously; to (5) indicating strong to very strong steady fixation for 10secs or more.

Table 4.2: System for ranking position maintenance

5	Very Strong	Steady fixation for more than 10 sec.
4	Strong	Steady fixation for at least 10 sec.
3	Adequate	Steady fixation for at least 5 sec.
2	Weak	Steady fixation for less than 5sec. or hand support needed
1	Very Weak	Unsteady fixation almost continuously

4.7.5.2 Pursuit eye movements

The most commonly used clinical method for the evaluation of the pursuits is the direct observation of the eyes following a moving target. The test was performed with the respondent standing directly in front of the examiner (investigator/ student).

The pursuit eye movements were tested monocularly and binocularly at a distance of 40cm with the respondent maintaining a well balanced posture while standing. Respondents were instructed to follow a target that was moved through the horizontal, vertical, diagonal meridians as well as through a circle. The target was held by the examiner at the midline of the respondent's body and moved in a circle of no more than 20cm in diameter estimated. Two rotations were made clockwise and two counter clockwise. A sweep horizontally through the midline of the body was made when switching from clockwise to counter clockwise rotation (Scheiman and Wick, 2002).

The examiner observed the pursuit eye movements and rated the performance in four categories including head movement, body movement, ability, and accuracy using the 5-point scale (Table 4.3) for the scoring criteria.

Table 4.3: NSUCO Scoring Criteria: Direct observation of pursuits

Ability Points	**Observation**
1	Cannot complete ½ rotation in either clockwise or counter clockwise direction
2	Completes ½ rotation in either direction
3	Completes one rotation in either direction but not 2 rotations
4	Completes 2 rotations in one direction but less than 2 rotations in the other direction
5	Completes 2 rotations in each direction
Accuracy Points	**Observation**
1	No attempt to follow the target or requires greater than 10 fixations
2	Refixations 5 to 10 times
3	Refixations 3 to 4 times
4	Refixations 2 times or less
5	No refixations
Head and Body Movements Points	**Observation**
1	Large movement of the head or body at any time
2	Moderate movement of the head or body at any time
3	Slight movement of the head or body (>50% of time)
4	Slight movement of the head or body (<50% of time)
5	No movement of head or body

The oculomotor skills were then ranked from 5 (best) to 1 (worst). Completion of two rotations in each direction (clockwise and counter clockwise) with no refixations and no head or body movements was rated as normal, and abnormal if the respondent could not complete ½ a rotation in either clockwise or counter clockwise direction, if they show refixations 5 to 10 times or more or shows large movements of the head or body at any time.

4.7.5.3 Saccadic eye movements

The evaluation of saccadic eye movements involved the examiner holding two different targets. Using the Gulden fixation stick green and red stickers were placed on each stick. The test was performed at approximately 40cm from the respondent, and on verbal command the child was instructed to move the eyes to the appropriate target. This was repeated until the respondent made five round trips or ten fixation movements from one target to another. The testing was performed in the horizontal, vertical, and diagonal meridians, monocularly and binocularly (Scheiman and Wick, 2002).

Using the NSUCO four categories of performance were rated including head movement, body movement, ability, and accuracy. The scoring criteria were based on the 5-point scale of NSUCO with 5 (best) to 1 (worst) see table 4.4 below. The children were regarded as normal if they completed 5 round trips, meaning that no overshooting was noted, and no head movements were observed, but abnormal if they completed less than 2 round trips, with large over- or undershooting noted 1 or more times, and with large movements of the head or body.

Table 4.4: NSUCO Scoring Criteria: Direct observation of saccades

Ability

Points	**Observation**
1	Completes < 2 roundtrips
2	Completes 2 roundtrips
3	Completes 3 roundtrips
4	Completes 4 roundtrips
5	Completes 5 roundtrips

Accuracy (Can the patient accurately and consistently fixate so that no noticeable correction is needed?)

Points	**Observation**
1	Large over- or undershooting noted 1 or more times
2	Moderate over- or undershooting noted 1 or more times
3	Constant slight over- or undershooting noted (>50% of time)
4	Intermittent slight over- or undershooting noted (<50% of time)
5	No over or undershooting noted

Head and body movement (Can the patient accomplish the saccade without moving his/her head?)

Points	**Observation**
1	Large movement of the head or body at any time
2	Moderate movement of the head or body at any time
3	Slight movement of the head or body (>50% of time)
4	Slight movement of the head or body (<50% of time)
5	No movement of head or body

4.8 OCULAR HEALTH

Ocular health assessment involved the assessment of the ocular structures externally and internally. The external parts of the eyes were evaluated using the direct observation method, and the penlight torch. Internal evaluation of the ocular structures was investigated using the ophthalmoscope. The external evaluation involved the surveying of the anterior segment which included the orbital size, shape and position; lid position, appearance, and action; lash position and appearance; sclera and conjunctiva colour and vascular appearance; corneal size and clarity; iris appearance and colour; anterior chamber depth and clarity, and the lens's general appearance. Additional to direct observation the lid and orbital area palpations were done to detect any orbital, lid, or lacrimal system abnormalities.

An ophthalmoscope was used to evaluate the posterior segment whereby the examiner held an ophthalmoscope at about 20cm away from the child and then moved slowly closer to the patient's eye while increasing or reducing the plus lenses until the fundus came into focus depending on whether the child was myopic or hyperopic. The clarity of the vitreous; optic disc colour, cup-to-disc ratio, depth and vascular topography; retinal background colour and appearance; retinal vascular topography, tortuosity, and arterial/venous ratio; macular colour and appearance were investigated (Carlson, et al. 1996). Compliance in evaluating the health status internally and externally was not a problem since the respondents were of school-going-age. Thus it was not necessary to do a dilated examination, especially for internal evaluations on any of the respondents.

The proceeding section explains the specific statistical analysis conducted on the collected data of the specific variables gathered in this study.

4.9 STATISTICAL ANALYSIS

Kerlinger (1986) (in De Vos, 1998) stated that raw data is difficult or impossible to explain, and thus it is important to analyse the data to be able to interpret the results of the data collected. According to De Vos (1998) the importance of statistics is to manipulate and summarize numerical data and to be able to compare the results obtained with chance expectations, leading to the answering of the research question.

In the current study the quantitative data was statistically analysed using the SPSS12 for windows computer (STATKON, University of Johannesburg 2006). The cross tabulations referred also to bivariate tables (Hatch, 1998, Eiselen, Uys, and Potgieter, 2005) were utilized. The cross tabulations involved the two-by-two tables which according to Hatch, 1998 can be used to calculate the sensitivity and specificity of a screening test.

The cross tabulations were found to be ideal in the current study due to the fact that according to Powers, 1985 (in De Vos 1998), they are created whenever subjects are classified (for example the learning disabled or children from the mainstream school) in relation to two separate qualitative variables (males and females) simultaneously for purposes of determining their degree of association.
In the current study the data was analysed by first describing the demographic variables, serving as the independent variables in the research. The independent variables were described with the use of frequency tables.

The second step taken was to examine if the relationship or an association existed between the independent variables (learning disabled or the mainstream group) and the dependent variables (for example reduced visual acuities, high refractive, accommodation infacility, poor vergences, or poor ocular motilities). Both the independent and the dependent variables in the current study are referred to as the nominal variables.

Furthermore in the second step of analysing the data, to determine whether the results obtained (for example the existence of a relationship) in a sample were due purely by chance or were a reflection of what is happening in the sample population, hypothesis testing was used. Two hypothesis were stated which are the null-hypothesis (or hypothesis of independence) and an alternative hypothesis. The Chi-Square test (Eiselen et al, 2005) was used to calculate the p-value. The p-value of less than 0.05 (null hypothesis is rejected) implied that it is highly unlikely that the results are due to chance only, thus implied that a relationship (or association) between the nominal variables existed. The p-value larger than 0.05 lead to the acceptance of the null hypothesis, thus leading to the conclusion that there is no relationship (or association) between the nominal variables, and therefore the results were only due to chance.

The third step in the statistical analysis of our data involved the quantification of the strength of the relationship between the nominal variables. Measures of association were used to establish the strength of the relationship (Eiselen et al, 2005). The commonly used measures of association include Phi co-efficient, Cramer's V and Contingency co-efficient (De Vos 1998). The Phi-coefficient was calculated using the two-by-two tables utilizing values ranging from -1 to 1. The "rule of thumb" for these interpretations referred to as effect sizes is as follows: less than 0.1 means no relationship, less than 0.3 means small effect (weak), 0.3 to 0.5 means medium to moderate effect, and more than 0.5 refers to large effect (strong) (Eiselen et al, 2005).

The value of less than 0.1 using the Cramer's V test means a very weak relationship between the nominal variables. Therefore although a high prevalence was identified in a particular sample group (e.g. learning disabled), and an association between the nominal variables was found to exist (p-value <0.05), the strength of the relationship is weak and therefore we could not safely say the nominal variables are associated to each other. The value calculated using the Cramer's V test that is more than 0.3 to 0.5 indicated a medium effect size, that a relationship of medium size existed between the nominal variables. The large effect size more than 0.5, indicated that a strong relationship existed and thus we could safely conclude that a relationship existed between the nominal variables.

Cramer's V test is slightly different from the Phi coefficient since it does not give direction of the relationship. Contingency coefficients also establish the strength of the relationship between the rows and column variables. With the column taking on the value between 0 and 1, with 0 indicating no association between row and column variables and a value close to 1 indicating a high degree of association between the variables. The column variables do not provide an indication of the direction of the relationship. The stronger the association between the two variables, the more likely it can be assumed that higher values in the one variable coincide with high values in the other variable, depending on the direction of the relationship (Phi coefficient).

4.10 CONCLUSION

This study is a cross-sectional or correlation study, since it compares the prevalence of various visual skills between children with learning problems and those from the mainstream school. Three schools in the region of Johannesburg were selected to participate in the study. Of the three schools two were special schools (learning disabled) and one was the mainstream. From both schools 192 subjects from grade 3 and 4 with their ages ranging from 8 to 13 years were purposively selected. The subjects from the special schools were not categorized according to the type of learning disabilities they had, nor was the information concerning academic performance of subjects from the mainstream school provided. The visual skills evaluated included visual acuities, refractive status, ocular health status, accommodation, vergence system and ocular motilities. The visual skills were evaluated in the form of a screening by the University of Johannesburg 4th year students under the supervision of the principal investigator.

The data collected from the subjects will be analysed in the subsequent chapter using the bivariate or integrated statistical method. This method uses the measures of association to compare the prevalence of visual disorders in the children with learning disabilities to those in the mainstream school. The hypothesis t-test was used in the presence of a high prevalence of visual disorders in any group to test if there is a relationship between the nominal variables. Cramer's V test was used in the presence of a relationship to test the strength of the relationship. The stronger the relationship then the more significant the relationship is between the nominal variables.

The following discussion will be about the results and the conclusion reached in this study based on the bivariate statistical analysis.

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CHAPTER 5

DATA ANALYSIS AND RESULTS

5.1 INTRODUCTION

The purpose of this study was to investigate the prevalence of visual deficiencies in children with learning disabilities compared to children in mainstream schools. The concept learning disability has been defined in Chapter 1&2, whereby the common characteristics found in children with learning disabilities have been discussed. The common characteristics include disorders of attention, failure to develop and mobilize cognitive strategies of learning, poor motor abilities, perceptual and information processing problems, oral language difficulties, reading difficulties, written language difficulties, mathematics difficulties, and inappropriate social behaviour.

This Chapter provides an analysis of the data that was collected at three sample schools in Johannesburg area. The analysis follows accepted procedures beginning with a presentation of demographic statistics, followed by comparisons between the learner groups regarding the different visual evaluations performed. Several hypotheses were tested using the cross tabulations and Chi-square tests (for the p-value) and Cramer's V tests to determine the strength of the relationship between the variables.

5.2 DATA COLLECTION

The data was collected over a period of six months during 2005. Two specific problems were encountered during the process of data collection. Firstly it was not possible to obtain information regarding specific learning disabilities of the different sample groups. Since this was regarded as confidential information by the school authorities, categorization into types of learning disabilities was not possible. Respondents with learning disabilities were thus categorized only by the schools they were attending at the time of the study. Thus it was assumed that learners from the two special schools were learning disabled and learners from the mainstream school were not learning disabled. Information about the academic performance of learners in the mainstream school that may have indicated a potential learning disability was not provided to the researcher.

The second problem that was encountered refers to the actual data collection. Due to factors beyond the control of the researcher such as university holidays some of the fieldwork had to be carried out by the researcher herself. Although this was not a serious problem it is realized that the period of data collection was extended possibly contributing to instability in the research population. It is possible that the demographics of the sample population could have been altered due to changes that occur over time. However in this project such influences are not a matter of much concern as the sample remains a snapshot of a particular setting.

5.3 THE DATA COLLECTION PROCEDURES

The data collection procedures consisted of a battery of visual evaluation tests that were used as indicated in Chapter 4. This battery is attached as Annexure A.

During data collection the complete battery of visual evaluations could not be administered to all of the respondents. This inability may be attributed to the fact that some respondents were not able to understand the different evaluations. Since this lack of understanding might have compromised the accuracy of data it was decided to exclude such cases in applicable sections of the analysis. The size of the realized sample was 192, however for the visual acuities at near 161 responded. In evaluating the refractive status of the right and left eyes a total of 191 and 190 respondents were assessed respectively. For the cover test, near point of convergence, step vergences, vergence facility and ocular motilities, 190, 187, 160, 177 and 191 respondents were assessed respectively as indicated in the Tables in the next section (5.4). In the following section the analysis of data is presented.

5.4 DEMOGRAPHIC STATISTICS

The following section provides descriptive statistics for the different biographical variables in the study.

5.4.1 Distribution of sample across schools

A total number of 192 respondents aged between 8 and 13 years participated in this study. The respondents were in grade 3 and 4 and from the schools of the learning disabled, 49 were from Lantern, and 63 were from the School of Achievement with 80 children from the mainstream school I.H. Harris Primary (see Table 5.1 below).

The two schools of children with learning disabilities, Lantern and School of Achievement had approximately 75% to 80% Caucasian scholars, and 20-25% Africans. I.H. Harris primary school which is situated in the centre of Johannesburg (Doornfontein) had 100% African children who mainly came from disadvantaged backgrounds (orphans, parents domestic workers or unemployed). The background factor may have contributed to the difficulty to complete some of the evaluations as indicated before. The visual evaluations took 6 months (from March 2005 to August 2005). At some stage the fourth years were on recess and not available, and the principal investigator had to do the evaluations herself. Table 5.1 provides a frequency distribution of the sample as distributed across the three schools in the sample.

Table 5.1 Frequency distribution of respondents across target schools

School				
		Frequency	Percent	Cumulative Percent
Valid	Achievement	63	32.8	32.8
	Lantern	49	25.5	58.3
	Harris	80	41.7	100.0
	Total	192	100.0	

As Table 5.2 below indicates, the respondents were divided into two groups, the learning disabled, and the control group from the mainstream school. From the learning disabled school 112 respondents participated in the study, and 80 respondents were from the mainstream school. This information is graphically depicted on the Figure 5.1 below, showing that the learning disabled respondents are more than the mainstream group.

Table 5.2: Distribution of respondents across learning disabled and mainstream schools

Group				
		Frequency	Percent	Cumulative Percent
Valid	Learning disabled	112	58.33	58.33
	Main	80	41.67	41.67
	Total	192	100.0	100.0

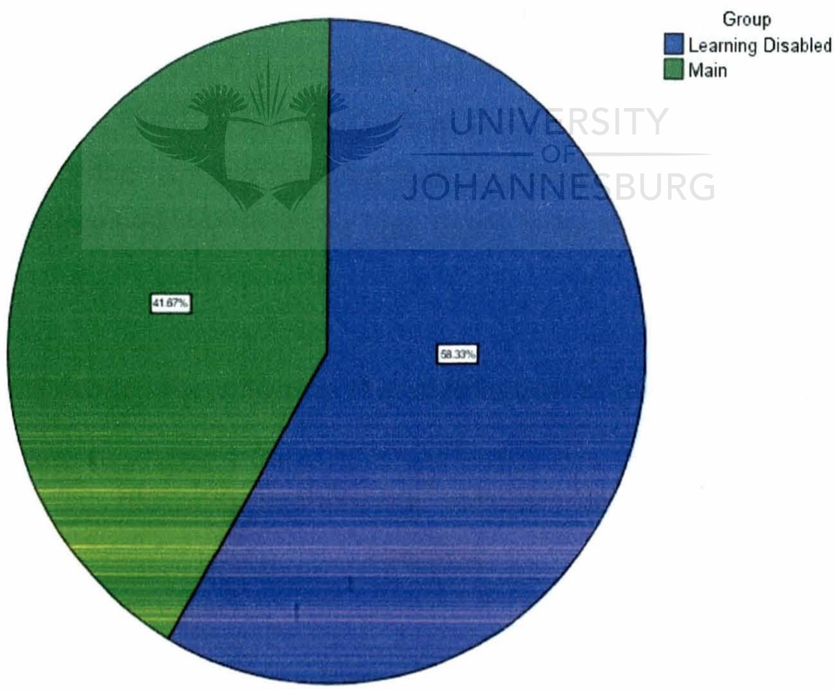

Figure 5.1: Pie graph demonstrating the distribution of the learning disabled and the mainstream group

5.5 RELATIONSHIP BETWEEN GENDER AND LEARNER GROUPS

From the three schools 109 respondents were boys and 82 were girls, with the gender information of one respondent missing due to incomplete information taken when filling in the demographic data on the record card (see Table 5.3 below).

Table 5.3: The cumulative frequency distribution of males and females involved in the study

Sex

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	109	56.8	57.1	57.1
	Female	82	42.7	42.9	100.0
	Total	191	99.5	100.0	
Missing	System	1	.5		
Total		192	100.0		

As the frequency Table 5.4 below shows an imbalance between males and female respondents was noted. A high percentage (63%) of male respondents was found in the school of the learning disabled than the females (37%). In the mainstream school the percentage of the males was found to be less (48%) than the females (52%).

Table 5.4: A cross tabulation on the distribution of males and females from the

learning disabled and mainstream schools

Crosstab

			Sex		Total
			Male	Female	
Group	Learning disabled	Count	71	41	112
		% within Group	63.4%	36.6%	100.0%
	Main	Count	38	41	79
		% within Group	48.1%	51.9%	100.0%
Total		Count	109	82	191
		% within Group	57.1%	42.9%	100.0%

The descriptive statistics below indicate that the learning disabled group was composed of more males than females, and the mainstream group had more females than males (see Figure 5.2 below).

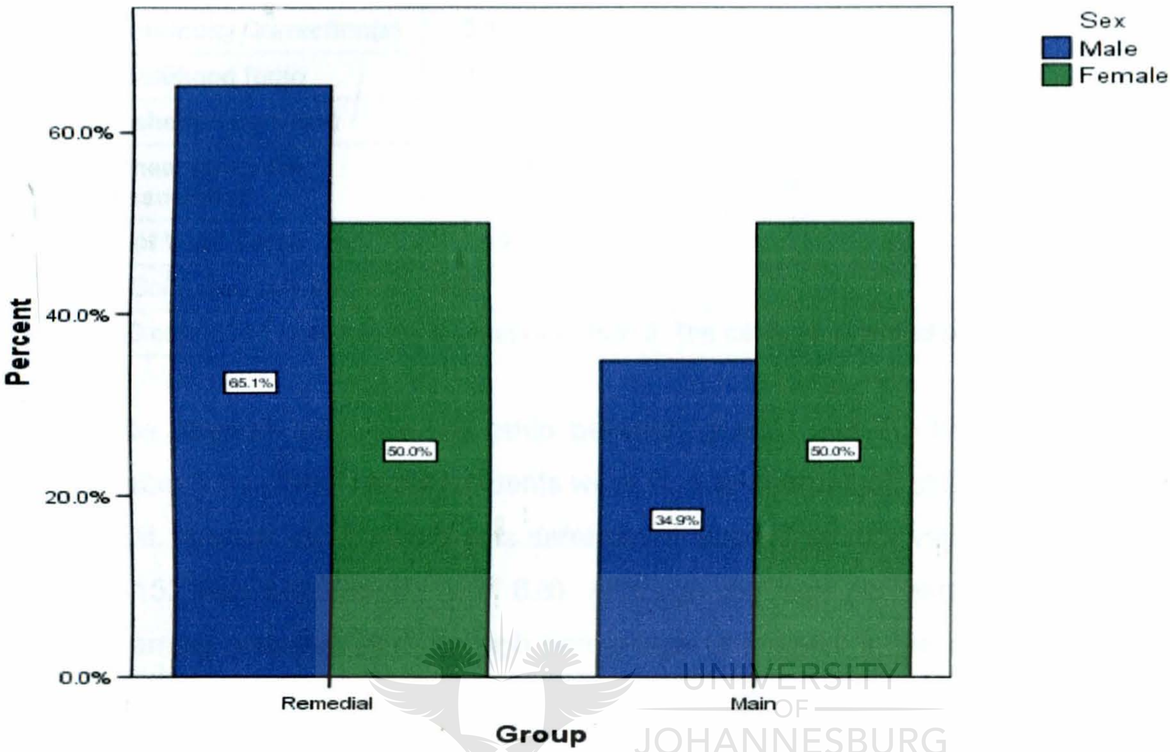

Figure 5.2: Bar graph showing distribution of males and females involved in the study

The null hypothesis here therefore is that the variable "gender" has an influence on the respondents being classified as learning disabled or not. For example do we have more males labelled as learning disabled than females? To test if the relationship can be observed between gender and the two groups (the learning disabled and mainstream group), and if it is statistically significant, the Pearson Chi-Square score was utilized. The p-value calculated is 0.039 (<0.05), therefore we reject the null hypothesis and conclude that a statistically significant relationship exists between the high percentage of boys in the schools of the learning disabled, and the high percentage of girls in the mainstream school (see Table 5.5 below).

Table 5.5: The relationship between the groups and gender: Chi-Square test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.421(b)	1	.035		
Continuity Correction(a)	3.819	1	.051		
Likelihood Ratio	4.419	1	.036		
Fisher's Exact Test				.039	.025
Linear-by-Linear Association	4.398	1	.036		
N of Valid Cases	191				
A Computed only for a 2x2 Table					
B 0 cells (.0%) have expected counts less than 5. The minimum expected count is 33.92.					

The strength of the relationship between gender and the type of schools (see Table 5.6 below) the respondents were in, was determined utilizing the Cramer's V test. A weak relationship was determined since Cramer's value was found to be 0.152 (lies between 0.1 and 0.3). Although the high percentage of males in the learning disabled, and the high percentage of females in the mainstream schools were observed, the Cramer's value determined a weak relationship between the variables thus we cannot safely conclude that learning disability is associated with males and the mainstream school is associated with females.

Table 5.6: The relationship between the groups and gender: Cramer's V test

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	**Phi**	.152	.035
	Cramer's V	.152	.035
N of Valid Cases		191	
a Not assuming the null hypothesis.			
b Using the asymptotic standard error assuming the null hypothesis.			

5.6 THE RELATIONSHIP BETWEEN LEANER GROUPS AND AGE

According to the South African Schools Act, 1996 (Act No. 1867 President's Office, 15th November 1996), education is compulsory for children between the ages of 7 and 15 years. Children who are 7 years old are thus expected to be in grade 1, and the average age of the children in grades 3 and 4 is 9 to 10 years. It is thus assumed that the older children (12 to 13 year olds) could be due to poor academic performance, and thus the children could have been held back, since they could not perform at the same level as the other children in their age group. The respondents were between the ages of 8 and 13 with the mean ages of 10.30 years (see Table 5.7 below). The months were rounded off, for example for the respondents who were 10 years 1 to 11 months they were regarded as being 10-years of age.

Table 5.7: The age distribution of the combined groups

Statistics
Age

N	**Valid**	192
Mean		10.30
Median		10.00
Std. Deviation		.999
Skewness		.510
Kurtosis		-.255

Table 5.8 below shows that the majority of the respondents (44.8%) were 10 years of age, with the minority 1 and 3 respondents aged 8 and 13 years respectively.

Table 5.8 The cumulative frequency distribution of the ages for the combined groups

Age				
	yrs	Frequency	Percent	Cumulative Percent
Valid	8	1	.5	.5
	9	38	19.8	20.3
	10	86	44.8	65.1
	11	39	20.3	85.4
	12	25	13.0	98.4
	13	3	1.6	100.0
	Total	192	100.0	

As indicated in the Table 5.9 below, the percentage of 10-year-olds is high 50% in the mainstream school and low in the school of the learning disabled 41.1%. The percentage of respondents in the 8 to 9 years old age group was found to be high 30% in the mainstream school than in the learning disabled. In the mainstream school the percentage of respondents in the 8 to 10-year-old were found to be high (80%), compared to the 54% in the same age group at the schools for the learning disabled. This analysis is in agreement with our presumption that the minority (14.6%) from the 12-13-year-old group in the schools of the learning disabled could have been held back a grade or two due to their poor academic performance. The majority (45%) of the learning disabled are in the 11 to 13 years old age group, compared to the mainstream school with 20%. As stated in the previous Chapter the information on the academic performance of respondents in the mainstream was not provided and thus amongst the 20% in the 11 to 13 years old age group, respondents who are one or two levels below that of children in their age group could also have participated in the study.

Table 5.9: The relationship between learning disabled and mainstream groups and age

Crosstab

			(R)Age				Total
			8 – 9	10	11	12 – 13	
Group	Learning disabled	Count	15	46	27	24	112
		% within Group	13.4%	41.1%	24.1%	21.4%	100.0%
	Main	Count	24	40	12	4	80
		% within Group	30.0%	50.0%	15.0%	5.0%	100.0%
Total		Count	39	86	39	28	192
		% within Group	20.3%	44.8%	20.3%	14.6%	100.0%

In the bar graph below respondents from the two groups (learning disabled and mainstream group) were divided into two groups the 8-10 and 11-13 year olds. The graphical analysis indicates that there is a higher percentage of the 11-13 year olds in the learning disabled than in the mainstream group. The mainstream group is composed of more 8-10 year olds than the learning disabled group.

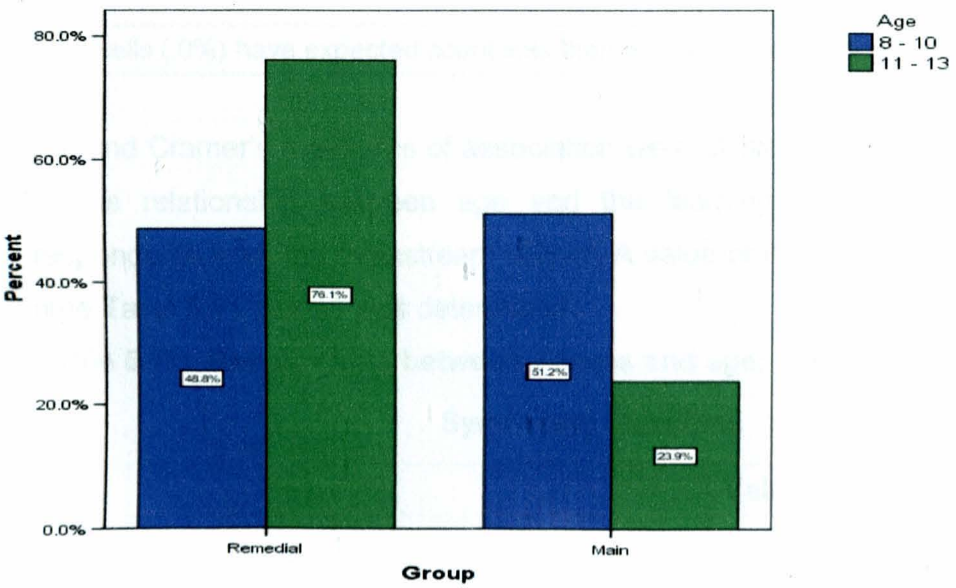

Figure 5.3: Bar graph showing the age distribution in the learning disabled and mainstream group

The important question to ask is: Is there a relationship between age and the two groups? Age is a variable that could influence our findings since according to the definition of learning disabilities; maturational lag (Piaget's theory, 1970) can lead to the individuals becoming learning disabled.

To determine if there is a relationship between the schools and the age groups, Pearson Chi-Square test was used and resulted in a p-value of 0.001. The p-value is less than 0.05, thus leading to the rejection of the null hypothesis (see Table 5.10 below). With the rejection of the null hypothesis this leads to the conclusion that a statistically significant relationship exist between the 11-13 year olds and the learning disabled group as well as between the mainstream group and the 8-10 year olds.

Table 5.10: The relationship between groups and age: Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	17.709(a)	3	.001
Likelihood Ratio	18.927	3	.000
Linear-by-Linear Association	17.607	1	.000
N of Valid Cases	192		
a 0 cells (.0%) have expected count less than 5. The minimum expected count is 11.67.			

Phi and Cramer's measures of association were utilized to determine the strength of the relationship between age and the learning disabled as well as the respondents from the mainstream school. A value of 0.304 (between 0.3 and 0.5) (see Table 5.11 below) was determined.

Table 5.11: Relationship between groups and age: Cramer's V test

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	**Phi**	.304	.001
	Cramer's V	.304	.001
N of Valid Cases		192	
a Not assuming the null hypothesis.			
b Using the asymptotic standard error assuming the null hypothesis.			

This value indicates that a moderate relationship exists between the age and the two groups. Thus leading to the conclusion that age does contribute to the child being in a mainstream or learning disabled school. This finding is in agreement with the education policies of South Africa, that 7 year-olds are expected to be in grade 1, and the average age of the children in grades 3 and 4 is 9-10 years. It is therefore in agreement with the assumption that the older children (12-13 year olds) in the same grades (3^{rd} and 4^{th}) as the 9-10 year olds are held back due to learning disabilities.

5.7 THE RELATIONSHIP BETWEEN GENDER AND AGE

It is important in this study to establish if there is a relationship between gender and age, in order to establish if the two variables have any impact on the visual evaluations performed on the two groups. The subjects were divided into four groups, the 8-9; 10; 11; and the 12-13 year olds. The percentage of the 10 year olds was found to be (44.5%), higher than the three age groups (see Appendix A, Table 1). Of the 44.5% respondents in the 10 year old age group, 51 were males with 34 being females. In determining the level of significance of the relationship between gender and age the p-value is 0.794, leading to the acceptance of the null hypothesis. Therefore leading to the conclusion that age is not associated with gender (see Appendix A, Table 2), and that the high percentage of the 10 year olds in the male population is due to chance alone.

5.8 VISUAL ACUITIES

5.8.1 The frequency distribution of visual acuities in the learner groups combined

Of the 192 respondents involved in the study the visual acuities data collected is displayed in Table 5.12 below. The table shows the visual acuities at distance (6 meters) and near (40cm) for the right, left and both eyes, tested using the Snellen Letter Acuity Chart. Of the 192 respondents only 161 had their near visual acuities measured. This was due to the fact that about 31 respondents from Lantern school only had their distance visual acuities evaluated. The near visual acuities were not measured on all respondents from Lantern school, since they were the first to be screened, and the responses were found to be poor and not correlating with the refractive errors as determined by the retinoscopy. The percentage of below normal (6/9 and worse) visual acuities according to Rosenbloom & Morgan (1990), for the whole group was found to be 16.1% for distance vision in the right eye, and 13.5% for the left eye, with the percentages for the normal visual acuities being 83.9% and 86.4% for the right and left eye respectively (see Table 5.12 below). The percentage of poor near visual acuities was found to be low 10.6% for the right and left eye compared to the 89.4% normal visual acuities.

Table 5.12:..The frequency distribution of visual acuities in the two groups combined

		Normal	Below Normal	Total
Visual acuities 6m: RE	Count	161	31	192
	%	83.9%	16.i %	100.0%
Visual acuities 6m: LE	Count	166	26	192
	%	86.5%	13.5%	100.0%
Visual acuities 6m: BE	Count	170	22	192
	%	88.5%	11.5%	100.0%
Visual acuities 40cm: RE	Count	144	17	161
	%	89.4%	10.6%	100.0%
Visual acuities 40cm: LE	Count	144	17	161
	%	89.4%	10.6%	100.0%
Visual acuities 40cm: BE	Count	149	12	161
	%	92.5%	7.5%	100.0%

5.8.2 The relationship between the groups (learning disabled and mainstream) and poor distance visual acuities of the right eye

A high percentage (16.1%) of respondents with poor distance visual acuities in both groups was measured for the right eye (see Table 5.13 below). Of the 112 respondents in the learning disabled group 21.4% were found to present with below normal visual acuities of the right eye at distance compared to the, 8.8% in the mainstream group (see Table 5.13 below).

Table 5.13: Relationship between groups and visual acuities

Crosstab					
			Visual acuities 6m: RE		Total
			Normal	Below Normal	
Group	Learning disabled	Count	88	24	112
		% within Group	78.6%	21.4%	100.0%
	Main	Count	73	7	80
		% within Group	91.3%	8.8%	100.0%
Total		Count	161	31	192
		% within Group	83.9%	16.1%	100.0%

The bar graph below clearly indicates the high percentage of poor distance vision for the right eye in the learning disabled compared to the mainstream group.

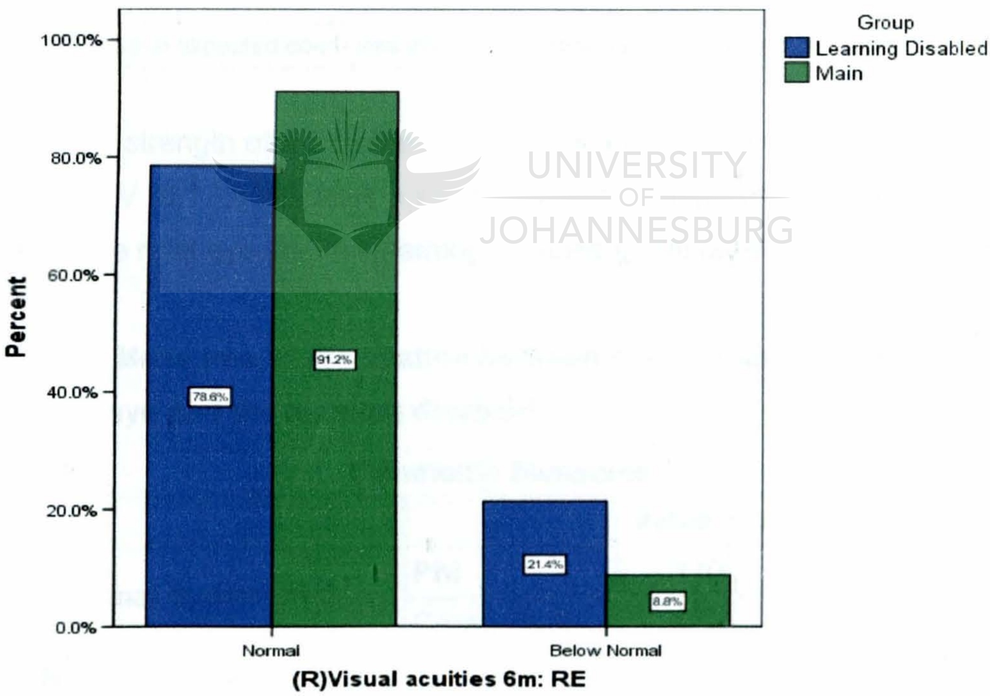

Figure 5.4: Bar graph showing the relationship between visual acuities (RE) @ 6m of both groups

In investigating if a relationship exists between poor distance visual acuity of the right eye and the learning disabled group, a p-value of 0.027 less than 0.05 was determined using the Chi-Square test. Hence this finding led to the conclusion that the relationship between poor distance visual acuity of the right eye and the learning disabled group is statistically significant (see Table 5.14 below).

Table 5.14: Relationship between poor visual acuities of the right eye in the learning disabled and the mainstream group

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	5.541(b)	1	.019		
Continuity Correction(a)	4.644	1	.031		
Likelihood Ratio	5.898	1	.015		
Fisher's Exact Test				.027	.014
Linear-by-Linear Association	5.512	1	.019		
N of Valid Cases	192				
a Computed only for a 2x2 Table					
b 0 cells (.0%) have expected count less than 5. The minimum expected count is 12.92.					

However the strength of the relationship between these two variables determined by Cramer's V (0.170) indicates a weak association between poor distance visual acuities of the right eye and the learning disabled group (see Table 5.15 below).

Table 5.15: Measures of association between poor visual acuities of the right eye and the learning disabled

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.170	.019
	Cramer's V	.170	.019
N of Valid Cases		192	
a Not assuming the null hypothesis.			
b Using the asymptotic standard error assuming the null hypothesis.			

5.8.3 The relationship between the learning disabled group and poor distance visual acuities of the left eye

Table 5.12 above demonstrates a high percentage (13.5%) of below normal distance visual acuities in the left eyes of the combined (learning disabled and mainstream) groups. Table 5.16 below indicates that of the 112 respondents from the learning disabled group, 19.6% have below normal visual acuities of the left eye, compared to the 5% in the mainstream group. Therefore a high percentage of poor distance visual acuities in the left eye of the learning disabled was observed, than in the mainstream group. The question of association between the learning disabled and the poor distance visual acuities of the left eye thus had to be addressed.

Table 5.16: The relationship between the learning disabled and poor distance visual acuities of the left eye

Crosstab

			Visual acuities 6m: LE		Total
			Normal	Below Normal	
Group	Learning disabled	Count	90	22	112
		% within Group	80.4%	19.6%	100.0%
	Main	Count	76	4	80
		% within Group	95.0%	5.0%	100.0%
Total		Count	166	26	192
		% within Group	86.5%	13.5%	100.0%

The percentage between reduced visual acuity of the left eye and the groups (the learning disabled and the mainstream schools) is displayed on the bar graph below.

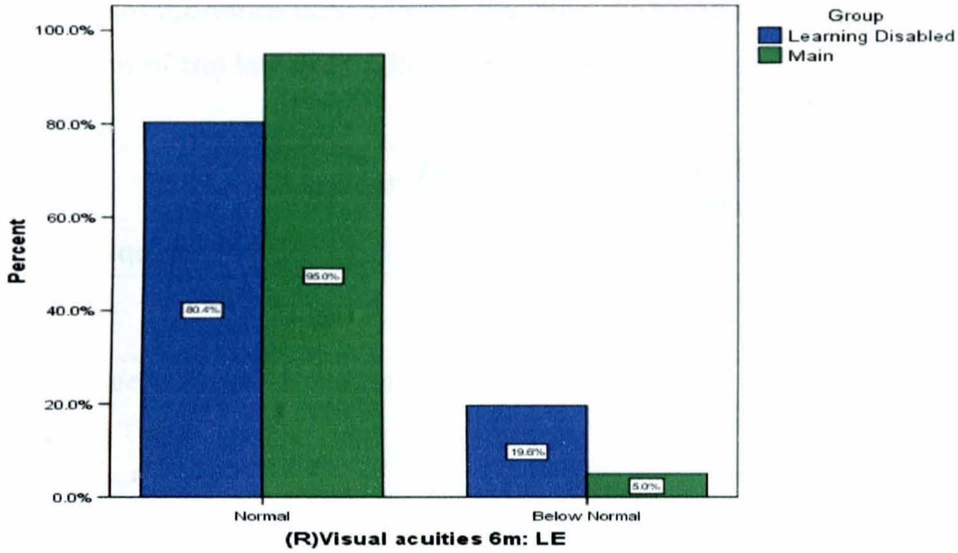

Figure 5.5: Bar graph showing the relationship between the groups(learning disabled and mainstream) and visual acuities (LE) @ 6m

To test if a relationship exists between poor visual acuities of the left eye and the learning disabled group (see Table 5.17), a p-value of 0.003 (<0.05) was determined using the Chi-Square test (see Table 5.17). Indicating that there is a statistically significant relationship between poor distance visual acuity of the left eye and the learning disabled (see Table 5.17 below).

Table 5.17: Relationship between the learning disabled and poor distance visual acuities of the left eye: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	8.546(b)	1	.003		
Continuity Correction(a)	7.341	1	.007		
Likelihood Ratio	9.543	1	.002		
Fisher's Exact Test				.005	.002
Linear-by-Linear Association	8.502	1	.004		
N of Valid Cases	192				
A Computed only for a 2x2 Table					
B 0 cells (.0%) have expected counts less than 5. The minimum expected count is 10.83.					

The strength of the relationship was determined using the Cramer's V measure of association. The value calculated is 0.211 indicating a weak relationship between poor distance visual acuities of the left eye and the learning disabled group (see Table 5.18 below). Although a high percentage of poor distance visual acuities of the left eye was found in the learning disabled, and a statistically significant association (p-value <0.05) determined, this association is negated by a weak relationship determined by Cramer's V test, therefore it cannot be safely concluded that children with learning disabilities have poor distance visual acuities of the left eye.

Table 5.18: Measures of association between the mainstream school and poor distance visual acuities of the left eye

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.211	.003
	Cramer's V	.211	.003
N of Valid Cases		192	
a Not assuming the null hypothesis.			
b Using the asymptotic standard error assuming the null hypothesis.			

5.8.4 The relationship between poor distance visual acuities of both eyes and the learner groups

The percentage of below normal visual acuities at distance for both eyes was found to be 11.5% for both groups combined, and 88.5% for the normal visual acuities (see Table 5.19 below). Of the 11.5% with below normal visual acuities 19 were from the school of the learning disabled and 3 were from the mainstream group (see Table 5.19 below).

Table 5.19:

The relationship between the groups and poor distance vision of both eyes

Crosstab

			Visual acuities 6m: BE		Total
			Normal	Below Normal	
Group	Learning disabled	Count	93	19	112
		% within Group	83.0%	17.0%	100.0%
	Main	Count	77	3	80
		% within Group	96.3%	3.8%	100.0%
Total		Count	170	22	192
		% within Group	88.5%	11.5%	100.0%

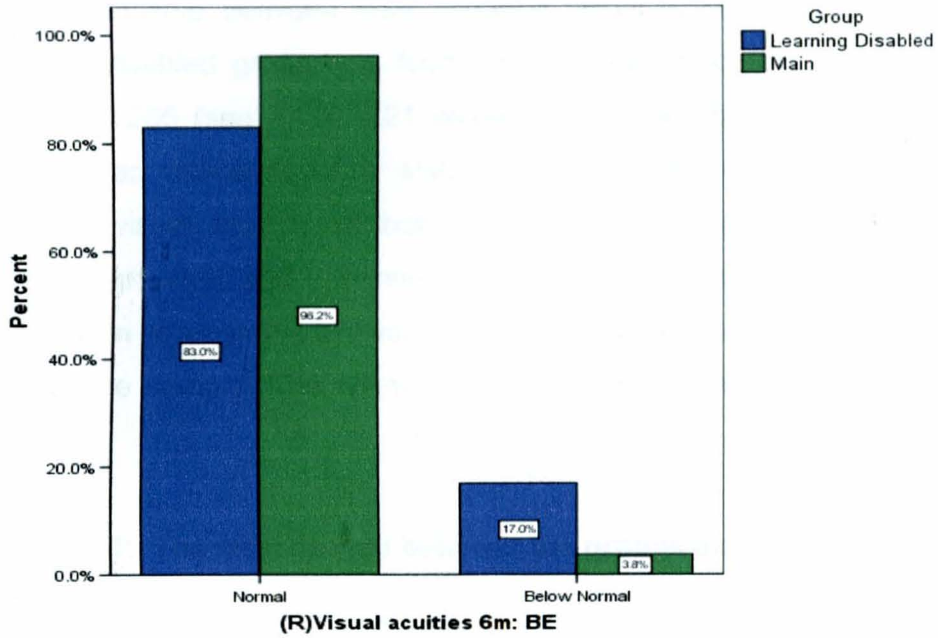

Figure 5.6: Bar graph showing the relationship between the groups and visual acuities @ 6m for both eyes

To test if a relationship exists between poor visual acuities of both eyes and the learning disabled group, the p-value of 0.005 was obtained (see Table 5.20 below), leading to the conclusion that a statistically significant relationship exist between below normal visual acuities at distance for both eyes and the learning disabled group.

Table 5.20

The relationship between the groups and poor distance vision of both eyes: Chi-Square Test

Chi-Square Tests					
	Value	**df**	**Asymp. Sig. (2-sided)**	**Exact Sig. (2-sided)**	**Exact Sig. (1-sided)**
Pearson Chi-Square	8.032(b)	1	.005		
Continuity Correction(a)	6.782	1	.009		
Likelihood Ratio	9.123	1	.003		
Fisher's Exact Test				.005	.003
Linear-by-Linear Association	7.990	1	.005		
N of Valid Cases	192				
a Computed only for a 2x2 Table					
b 0 cells (.0%) have expected count less than 5. The minimum expected count is 9.17.					

The relationship between poor distance visual acuities of both eyes and the learning disabled group was found to be weak, since the calculated Cramer's value is 0.205 (see Table 5.21 below). It can thus be concluded that although there is an indication of a statistically significant relationship between poor distance visual acuities of both eyes and the learning disabled group, this relationship weak and it cannot be safely concluded that there is a definite association between the two variables. This is perhaps due to the relative small size of the sample. The relationship should be explored further utilizing larger samples.

Table 5.21: The relationship between the groups and poor distance vision of both eyes

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.205	.005
	Cramer's V	.205	.005
N of Valid Cases		192	
a Not assuming the null hypothesis.			
b Using the asymptotic standard error assuming the null hypothesis.			

5.8.5 The relationship between the learner groups and poor near visual acuities of the right and left eyes

The near visual acuities at near for the right and left eyes are discussed together in this section, due to the fact that our data revealed no differences between the two eyes. Thirty one (31) children from Lantern Primary (remedial) did not have their visual acuities at near evaluated, only distance visual acuities were measured. This is due to the fact that Lantern was the first school to be screened and the responses were found to be poor and not correlating with the refractive errors as determined by the retinoscopy as mentioned in the above chapter.

Therefore out of the 192 children only 161 had their visual acuities measured. Of the 161 children evaluated as indicated in Table 5.21 below, 10.6% had below normal near visual acuities for the left and right eyes. From the cross tabulation below the mainstream group was found to have a lower percentage (8.5%) of poor near visual acuities in the right and left eye, compared to the 12.2% in the learning disabled group (see Table 5.22 below).

Table 5.22: The frequency distribution of visual acuities at near for both the right and left eyes in the groups

Crosstab

			Visual acuities 40m: RE & LE		Total
			Normal	Below Normal	
Group	Learning disabled	Count	79	11	90
		% within Group	87.8%	12.2%	100.0%
	Main	Count	65	6	71
		% within Group	91.5%	8.5%	100.0%
Total		Count	144	17	161
		% within Group	89.4%	10.6%	100.0%

In testing the hypothesis of independence between poor visual acuities at near for the right and left eye with the learning disabled group, the p-value calculated was found to be 0.439 which is greater than 0.05 (see Table 5.23 below). This finding therefore supports the null hypothesis. In accepting the null hypothesis we conclude that a relationship does not exist between poor near visual acuities of the right and left eye and the learning disabled group.

Table 5.23: The relationship between the mainstream group and poor near visual acuities of the right and left eyes

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.598(b)	1	.439		
Continuity Correction(a)	.265	1	.607		
Likelihood Ratio	.608	1	.435		
Fisher's Exact Test				.607	.306
Linear-by-Linear Association	.594	1	.441		
N of Valid Cases	161				

a Computed only for a 2x2 Table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.50.

5.8.6 The relationship between poor near vision for both eyes and the learner groups

With reference to the cross tabulation below (Table 5.24), from the whole group of 161 children evaluated 7.5% had poor visual acuities at near with both eyes open. Of the 7.5% with poor visual acuities at near in both eyes, 12 were from the mainstream and 7 were from the learning disabled group.

Table 5.24: The frequency distribution of poor near visual acuities for both eyes in the two groups

Crosstab

			Visual acuities 40m: BE		Total
			Normal	Below Normal	
Group	**Learning disabled**	**Count**	83	7	90
		% within Group	92.2%	7.8%	100.0%
	Main	**Count**	66	5	71
		% within Group	93.0%	7.0%	100.0%
Total		**Count**	149	12	161
		% within Group	92.5%	7.5%	100.0%

To test if there is a relationship between poor near visual acuities with both eyes at near, a p-value of 0.860 (greater than 0.05) was determined using the Pearson Chi-Square test. With the p-value more than 0.05 we therefore accept the null hypothesis and conclude that no relationship exists between poor near visual acuities binocularly and the learning disabled group (see 5.25 below).

Table 5.25:

The relationship between poor visual acuities with both eyes and the mainstream: Chi-Square tests

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.031(b)	1	.860		
Continuity Correction(a)	.000	1	1.000		
Likelihood Ratio	.031	1	.860		
Fisher's Exact Test				1.000	.554
Linear-by-Linear Association	.031	1	.860		
N of Valid Cases	161				
a Computed only for a 2x2 Table					
b 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.29.					

5.8.7 The relationship between poor visual acuities at distance and different age groups

The respondents were divided into two age groups the 8-10 and 11-13 year-olds. The percentage of poor distance visual acuities was found to be high (20.8%, 17.6%, and 14.4%) in the 8-10 year olds for the right, left and both eyes respectively (see Appendix A, Tables 3, 6 & 9). The p-values for the right and left eyes determined by the Chi-Square test were found to be 0.017 and 0.025 respectively which are lesser than 0.05. Therefore leading to the conclusion that a statistically significant relationship exists between poor distance visual acuities of the right and left eye and the 8-10 year old age group (see Appendix A, Tables 4 &7). The relationship between the mentioned variables was found to be weak since Cramer's V is 0.173 and 0.162 for the right and left eyes respectively (see Appendix A, Tables 5 & 8). This indicates that although a relationship between poor visual acuities of the right and left eyes at distance with the 8-10 year-old age group was statistically significant (p-values <0.05), the strength of the relationship between the variables was found to be weak.

For the relationship between poor distance visual acuities in both eyes and the 8-10 year old age group, the p-value determined is 0.80, thus indicating that no relationship exists between the mentioned variables (see Appendix A, Table 10).

The prevalence of poor near visual acuities was found to be the same for the right and left eyes (13.8%) and for both eyes (10.6%) (see Appendix A, Tables 11&13) in the 8-10 year old age group. The associations between poor near visual acuity of the right, left and both eyes and the 8-10 year old age group were found not to exist since the p-values determined were 0.11 (right and left eye) and 0.125 (both eyes), greater than the required level of significance 0.05 (see Appendix A, Tables 12 & 14).

5.8.8 The relationship between poor distance/near visual acuities and gender

Since most of the variables in this section were found not to be associated the researcher chose to report on the results briefly.

a) Distance acuities and gender

The percentage of poor distance visual acuities was generally found to be high (20.7%, 18.3%, and 17.1%) for the right, left and both eyes respectively (see Appendix A, Tables 15, 17& 19). The relationships between poor distance visual acuities of the right and left eyes and gender were found not to exist since p-values of 0.143 and 0.102 were determined with the Pearson's Chi-square test (see Appendix A, Tables 16 & 18).

b) Distance visual acuities in both eyes and gender

Regarding poor distance visual acuities in both eyes and gender a statistically significant relationship was determined since a p-value of 0.037

(<0.05) was obtained (see Appendix A, Table 20). It is therefore concluded that females might have a higher percentage of poor distance visual acuities in both eyes than males. The relationship between poor distance visual acuities in both eyes and gender was however found to be weak since Cramer's V is 0.151 (see Appendix A, Table 21).

c) Near visual acuities and gender

Poor near visual acuities were found to be high and largely similar (15.9%) in the females for the right and left eye and less in males (6.7%) (see Appendix A, Table 22). A high (8.6%) percentage of poor near visual acuities was found in the females for both eyes (see Appendix A, Table 24). However no significant relationships were found to exist since the p-values were greater than 0.05, that is 0.065 (for the right and left eye) and 0.650 for both eyes (see Appendix A, Tables 23 & 24). Therefore it can be concluded that gender did not influence visual acuities (near or distance) in this sample.

5.9 REFRACTIVE ERRORS AND THE LEARNER GROUPS

In this section potential relationships between refractive errors and the learner groups will be evaluated by means of Pearson's Chi-square test and the Cramer's V measures of association.

5.9.1 The relationship between refractive errors for the right eye and learner groups

The refractive errors were evaluated in 191 respondents and only one child from the whole group did not have their refractive error determined. A high percentage (60.8%) of respondents in the mainstream group were found to be hyperopic than the 37.5% in the learning disabled group. Myopia, compound myopic astigmatism and mixed astigmatism had a high percentage of 9.8%, 16.1% and 36.6% respectively in the learning disabled group (see Table 5.26).

Table 5.26:

The relationship between refractive errors and the groups

Crosstab							
			Refractive Error: RE				Total
			Myopia	Hyperopia	Compound Myopic Astigmatism	Mixed Astigmatism	
Group	Learning disabled	Count	11	42	18	41	112
		% within Group	9.8%	37.5%	16.1%	36.6%	100.0%
	Main	Count	4	48	4	23	79
		% within Group	5.1%	60.8%	5.1%	29.1%	100.0%
Total		Count	15	90	22	64	191
		% within Group	7.9%	47.1%	11.5%	33.5%	100.0%

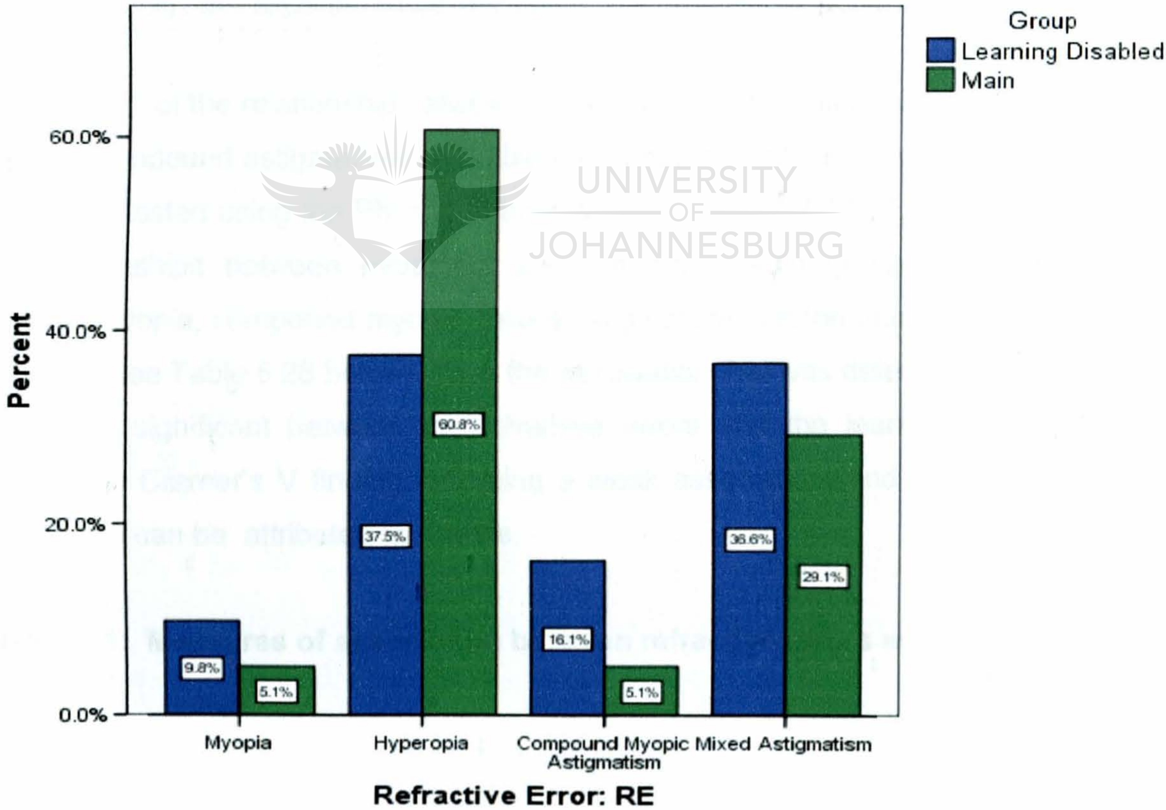

Figure 5.7: Bar graph showing the relationship between refractive error (RE) and groups

The spread of the refractive errors including myopia, hyperopia, compound myopia and mixed astigmatism is displayed on the bar graph above. The p-value calculated using the Pearson Chi-Square test is 0.006 (<0.05) (see Table 5.27 below). The null hypothesis is therefore rejected, thus leading to the conclusion that the association between hyperopia and the mainstream group and that between myopia, compound myopic astigmatism and mixed astigmatism and the schools of the learning disabled are statistically significant.

Table 5.27: Relationship between the refractive errors and the schools

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	12.304(a)	3	.006
Likelihood Ratio	12.835	3	.005
Linear-by-Linear Association	2.009	1	.156
N of Valid Cases	191		
a 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.20.			

The strength of the relationship between hyperopia and the mainstream group and myopia, compound astigmatism and mixed astigmatism with the learning disabled group was tested using the Phi and Cramer's V. The value of 0.254 indicates that the relationships between hyperopia and the mainstream group, as well as between myopia, compound myopic, mixed astigmatism and the learning disabled are weak (see Table 5.28 below). Thus the association that was determined to be statistically significant between the refractive errors and the learner groups is negated by Cramer's V finding indicating a weak association, and therefore the relationship can be attributed to chance.

Table 5.28: Measures of association between refractive errors and the schools

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	**Phi**	.254	.006
	Cramer's V	.254	.006
N of Valid Cases		191	
a Not assuming the null hypothesis.			
b Using the asymptotic standard error assuming the null hypothesis.			

5.9.2 The relationship between the refractive errors and gender

Hyperopia and myopic astigmatism were found to be high in males 48.1% and 33.2% respectively for the right eye. Myopia and compound myopic astigmatism were found to be high 8.5% and 12.2% respectively in females for the right eye (see Appendix B, Table 1). For the left eye hyperopia and mixed astigmatism were found to be the same in both the males and females. However the percentage of respondents with myopia in the left eye was found to be high 6.2% in the females than in males, and in the males the compound myopic astigmatism was found to be high 12% (see Appendix B, Table 3). The relationships between genders and refractive errors were found not to exist as determined by Pearson Chi-Square tests, whereby the p-values were (0.984 and 0.852) not less than 0.05 (see Appendix B, Tables 2 & 4).

5.9.3 The relationship between the refractive errors and different age groups

Myopia and compound astigmatism for the right eyes were found to be high 11.9% and 19.4% respectively in the 11-13-years-old age group, than the 5.6% and 7.3% respectively in the 8-10 year olds. In the 8-10-year-olds the percentage of hyperopia and mixed astigmatism were found to be 48.4% and 38.7% respectively, slightly higher than in the 11-13 years old age group 44.8% and 23.9% respectively (see Appendix B, Table 5).

In determining if the relationship exists between the above mentioned variables (myopia; compound astigmatism and the 11-13-years-old age group and between the 8-10 year olds and hyperopia; mixed astigmatism) the p-value of 0.013 (less than 0.05) was determined by Pearson-Chi-Square test (see Appendix B, Table 6). Thus leading to the conclusion that a statistically significant relationship exists between the mentioned variables, since the null hypothesis is rejected. The strength of the relationship as determined by the Phi and Cramer's V test was found to be weak (0.237) between the nominal variables (see Appendix B, Table 7). Thus leading to the conclusion that although the relationship between myopia; compound myopic astigmatism and the 11-13 year olds and that between the 8-10 year olds and hyperopia; mixed astigmatism was found to be statistically significant we cannot safely conclude an association between the above mentioned refractive errors and gender exists.

The respondents with hyperopia, and mixed astigmatism in the left eyes were more 43.5% and 42.7% in the 8-10-year-old age group respectively. In the 11-13 year old age group the percentage was high 7.6% and 12.1% for myopia and compound myopic astigmatism respectively (see Appendix B, Table 8). No relationship was found to exist between the above mentioned variables since the p-value of 0.555 using the Chi-Square test was determined (see Appendix B, Table 9).

5.10 ACCOMMODATION SYSTEM

In this section potential relationships between accommodation system and the learner groups were evaluated by means of Pearson's Chi-square test and the Cramer's V measures of association.

5.10.1 Accommodation accuracy

5.10.1.1 The distribution of accommodation accuracy in the groups

Of the 192 subjects, only 189 had the accommodation response of the right eye evaluated. A high lag (>+0.75) was found in 12 (6.3%) respondents with 43 (22.7%) subjects indicating a lead of accommodation (<+0.25) (see Table 5.29).

Table 5.29: Frequency distribution of accommodation accuracy for the right eye

Accommodation: Accuracy: RE			
		Frequency	Percent
Valid	Normal Lag	134	69.8
	High Lag	12	6.3
	Lead of Accommodation	43	22.4
	No Response	3	1.6
	Total	192	100.0

The Table below (5.30) demonstrates the distribution frequency of accommodation accuracy for the left eye. Of the 192 subjects involved in this study, 187 had the accommodation accuracy of the left eye assessed. A high lag of accommodation >+0.75 was found in 7.4% respondents and 23% had a lead of accommodation.

Table 5.30:

Frequency distribution of accommodation accuracy for the left eye

Accommodation: Accuracy: LE

		Frequency	Percent
Valid	Normal Lag	131	68.2
	High Lag	14	7.3
	Lead of Accommodation	43	22.4
	No Response	4	2.1
	Total	192	100.0

- **The relationship between groups and accommodation accuracy (re)**

A high lag of accommodation was found to be 9.8% in the learning disabled, more than the 1.3% in the mainstream group. A lead of accommodation was found to be high in the mainstream (40%) than in the learning disabled (9.8%) group (see Table 5.31 below).

Table 5.31:

The relationship between the groups and accommodation accuracy (RE)

Crosstab

			Accommodation: Accuracy: RE				Total
			Normal Lag	High Lag	Lead of Accommodation	No Response	
Group	Learning disabled	Count	88	11	11	2	112
		% within Group	78.6%	9.8%	9.8%	1.8%	100.0%
	Main	Count	46	1	32	1	80
		% within Group	57.5%	1.3%	40.0%	1.3%	100.0%
Total		Count	134	12	43	3	192
		% within Group	69.8%	6.3%	22.4%	1.6%	100.0%

The relationship of accommodation accuracy (RE) to the groups (mainstream and learning disabled) is displayed on the graph below.

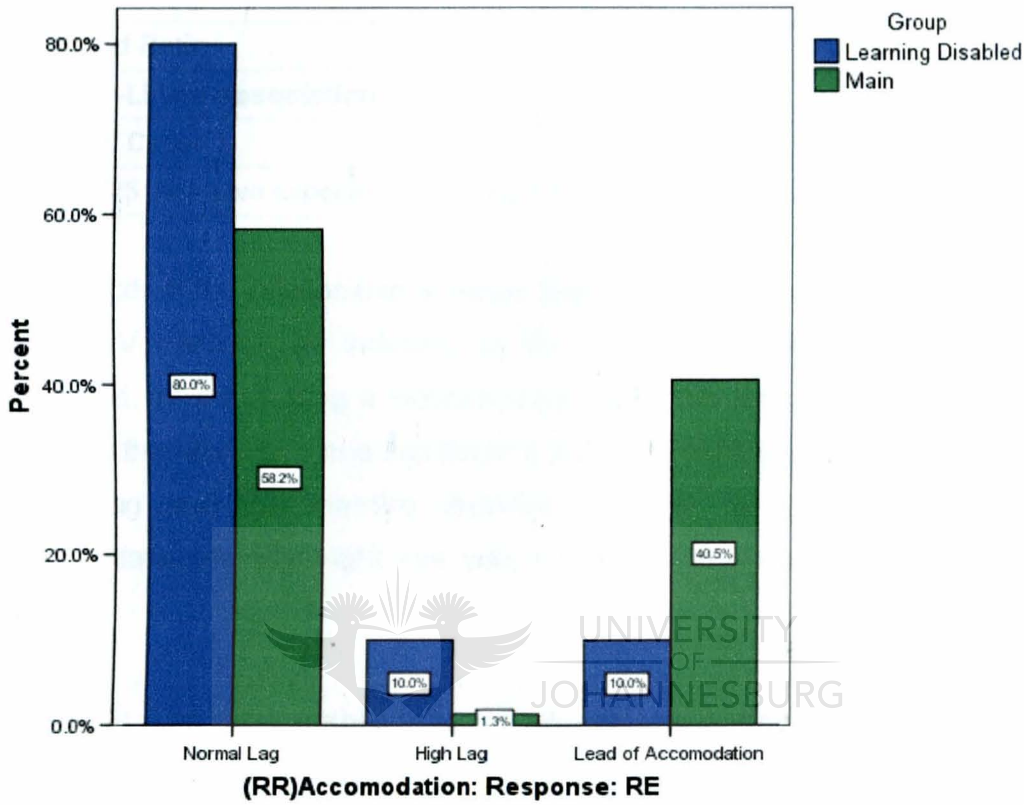

Figure 5.8: Bar graph showing the relationship between accommodation accuracy (RE) and learner groups

Pearson's Chi-Square test was used to test for the hypothesis of independence and a p-value of 0.000, which is less than 0.05, was determined (see Table 5.32 below). Thus leading to the conclusion that a statistically significant relationship exists between the high lag and the learning disabled, as well as between the lead of accommodation and the mainstream group.

Table 5.32: The relationship between the groups and accommodation accuracy (RE)

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	27.518(a)	3	.000
Likelihood Ratio	28.830	3	.000
Linear-by-Linear Association	6.738	1	.009
N of Valid Cases	192		

a 2 cells (25.0%) have expected count less than 5. The minimum expected count is 1.25.

The strength of the relationship between these variables was determined by using Cramer's V methods as indicated in the Table below. A value of 0.379 was determined, thus indicating a medium relationship between the nominal variables. The value therefore confirms that there is indeed a moderate association between a high lag and the learning disabled, as well as between the lead of accommodation for the right eye with the mainstream group (see Table 5.33 below).

Table 5.33: The relationship between groups and poor accommodation accuracy (RE)

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	**Phi**	.379	.000
	Cramer's V	.379	.000
N of Valid Cases		192	

a Not assuming the null hypothesis.

b Using the asymptotic standard error assuming the null hypothesis.

- **The relationship between groups and accommodation accuracy (LE)**

Of the 192 subjects only 187 had the accommodation accuracy for the left eye evaluated. Respondents with a high lag accommodation were found to be more 11.9% in the learning disabled, than the 1.3% in the mainstream group. In the mainstream 40.5% respondents were found to have a lead of accommodation more than in the learning disabled (10.1%) group (see Table 5.34 below).

Table 5.34: The relationship between the groups and accommodation accuracy (LE)

Crosstab

			Accommodation: Response: LE			Total
			Normal Lag	High Lag	Lead of Accommodation	
Group	Learning disabled	Count	85	13	11	109
		% within Group	78.0%	11.9%	10.1%	100.0%
	Main	Count	46	1	32	79
		% within Group	58.2%	1.3%	40.5%	100.0%
Total		Count	131	14	43	188
		% within Group	69.7%	7.4%	22.9%	100.0%

The relationship between accommodation accuracy for the left eye is indicated on the bar graph below. The bar graph clearly indicates a high percentage of normal accommodation accuracy 78% and 58.2% in the learning disabled and the mainstream group respectively.

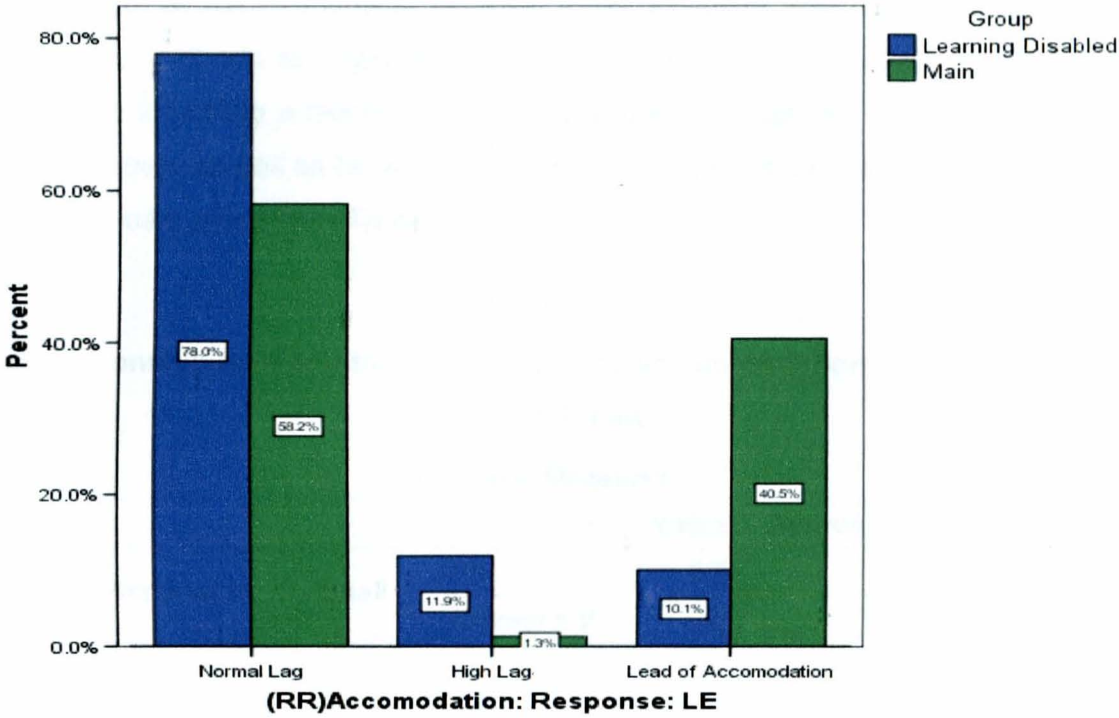

Figure 5.9: Bar graph displaying the relationship between accommodation accuracy and groups

Pearson's Chi- Square test was used to test for the hypothesis of independence and a p-value of 0.000, less than 0.05 was determined (see Table 5.35 below). Thus leading to the conclusion that a statistically significant relationship exists between the high lag in the left eye and the learning disabled, as well as between the lead of accommodation in the left eye and the mainstream group.

Table 5.35:

The relationship between mainstream school and the accommodation accuracy (LE): Chi-Square Tests

Chi-Square Tests			
	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	28.080(a)	2	.000
Likelihood Ratio	29.892	2	.000
Linear-by-Linear Association	16.232	1	.000
N of Valid Cases	188		
a 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.88.			

The strength of the relationship between these variables was determined using Cramer's V methods as indicated in the Table below. The value determined is 0.386, thus indicating a medium relationship between a high lag and the learning disabled group, as well as between the lead of accommodation for the left eye and the mainstream group (see Table 5.36 below).

Table 5.36:

The relationship between the groups and the accommodation accuracy (LE): Cramer's V test

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.386	.000
	Cramer's V	.386	.000
N of Valid Cases		188	

a Not assuming the null hypothesis.

b Using the asymptotic standard error assuming the null hypothesis.

5.10.1.2 The relationship between accommodation accuracy and age

The percentage of respondents with the high lag (>+0.75D) of accommodation for the right and left eyes was found to be high 10.7% in the 12-13 year old group. The percentage of respondents with the lead of accommodation for the right and left eyes were found to be high 27.7% and 27% respectively in the 10 year old age group (see Appendix C, Tables 1 & 3). The p-values for both age groups regarding the high lag and lead of accommodation were calculated to be 0.302 and 0.409, thus leading to the conclusion that no relationship exists between the mentioned variables (see Appendix C, Tables 2 and 4). Therefore age was found not to be associated with accommodation accuracy.

5.10.1.3. The relationship between accommodation accuracy and gender

The percentage of respondents with the high lag of accommodation was found to be high in males 6.5% for the right eye compared to the 6.2% in females (see Appendix C, Table 5). For the left eye the percentage of the high lag was found to be the same in both the males and the females. More females 23.5% presented with the lead of accommodation compared to the males (21.5%) (see Appendix C, Tables 5 & 7). The p-values calculated using the Chi-Square tests were 0.949 and 0.934 for the relationships between the genders and the high lag and lead of accommodation (see Appendix C, Tables 6 & 8). Therefore leading to the conclusion that gender does not have any influence on accommodation accuracy.

5.10.2 Accommodation facility

5.10.2.1 Frequency distribution accommodation facility

Accommodation facility was evaluated on 187 children from both groups, with five children not evaluated due to lack of understanding of the procedures. The levels of performance were divided into three categories, above average, normal and below average.

Of the 187 respondents evaluated, below normal accommodation facility was found in 14.4%, and 85.6% had normal and above average accommodation facility (see Table 5.37 below).

Table 5.37: Cumulative frequency distribution of accommodation facility

Accommodation Facility

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Above Average	44	22.9	23.5	23.5
	Normal	116	60.4	62.0	85.6
	Below Average	27	14.1	14.4	100.0
	Total	187	97.4	100.0	
Missing	System	5	2.6		
Total		192	100.0		

5.10.2.2 The relationship between accommodation facility and the learner groups

Of the 109 respondents from the schools of the learning disabled who had their accommodation facility evaluated, 18.3% had below average accommodation facility. The percentage of respondents with below average accommodation facility was found to be high (9%) in the mainstream group than in the learning disabled group (see Table 5.38 below).

Table 5.38: The relationship between groups and accommodation facility

Crosstab

			Accommodation Facility			Total
			Above Average	Normal	Below Average	
Group	Learning disabled	Count	29	60	20	109
		% within Group	26.6%	55.0%	18.3%	100.0%
	Main	Count	15	56	7	78
		% within Group	19.2%	71.8%	9.0%	100.0%
Total		Count	44	116	27	187
		% within Group	23.5%	62.0%	14.4%	100.0%

The relationship of poor accommodation facility in the learning disabled group is displayed on the bar graph below.

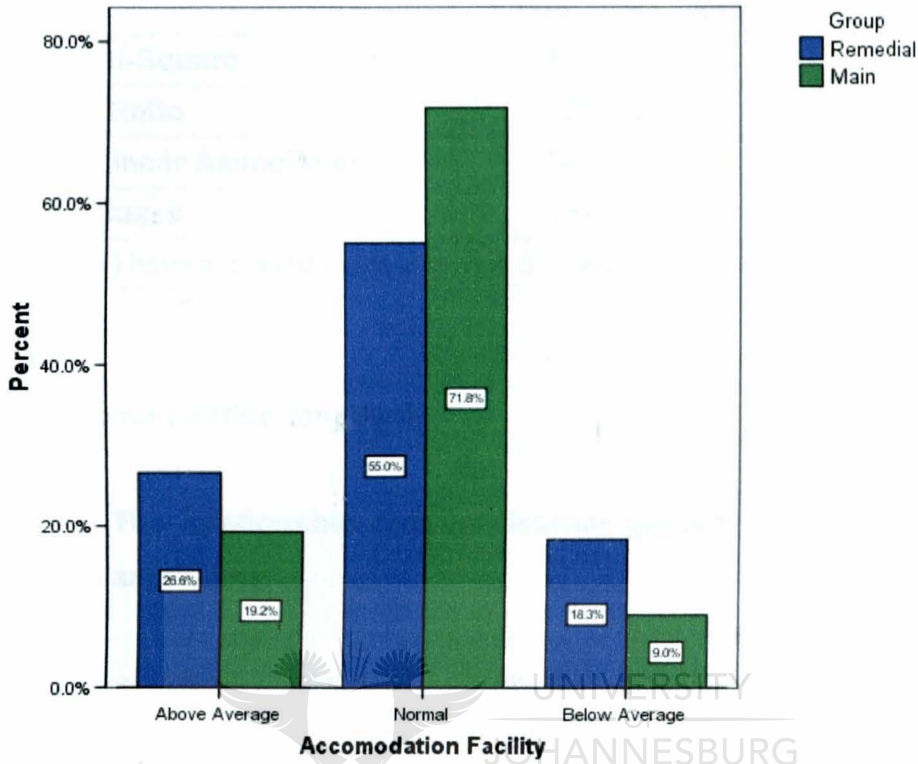

Figure 5.10: Bar graph showing the relationship between the groups and accommodation facility

According to the Pearson Chi-Square Test the p-value of 0.053 was calculated, the null hypothesis is thus accepted concluding that no relationship exists between poor accommodation facility and the learning disabled group (see Table 5.39 below).

Table 5.39: The relationship between the groups and accommodation facility

Chi-Square Tests	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.874(a)	2	.053
Likelihood Ratio	6.035	2	.049
Linear-by-Linear Association	.049	1	.825
N of Valid Cases	187		
a 0 cells (.0%) have expected count less than 5. The minimum expected count is 11.26.			

5.10.3 Accommodation amplitude

5.10.3.1 The relationship between learner groups and accommodation amplitude

Of the 192 respondents involved in the study, the amplitudes for the right eye were measured in 165 and for the left eye in 164 respondents. The 26 to 27 subjects were excluded due to lack of understanding of the test and thus poor responses. The respondents with below average amplitudes were found to be 37.6% and 37.8% (combined the two columns of slightly and extremely below average) for the right and left eye respectively. Cross tabulations for individual schools revealed high percentage 51.6% (combined the two columns of slightly and extremely below average) amplitudes of accommodation for the right eye in the respondents from the mainstream than the 29.1% in the learning disabled group. The percentage of respondents with poor amplitudes for the left eye was found to be high (53.3%) in the mainstream than in the learning disabled (28.8%) as indicated in Table 5.41 and 5.42 below.

Table 5.41: The relationship between groups and accommodation amplitude (RE)

			Accommodation: Amplitude: RE				Total
			Above Average	Average	Slightly Below Average	Below/Extremely Below / Ill-Sustained	
Group	Learning disabled	Count	60	13	17	13	103
		% within Group	58.3%	12.6%	16.5%	12.6%	100.0%
	Main	Count	21	9	25	7	62
		% within Group	33.9%	14.5%	40.3%	11.3%	100.0%
Total		Count	81	22	42	20	165
		% within Group	49.1%	13.3%	25.5%	12.1%	100.0%

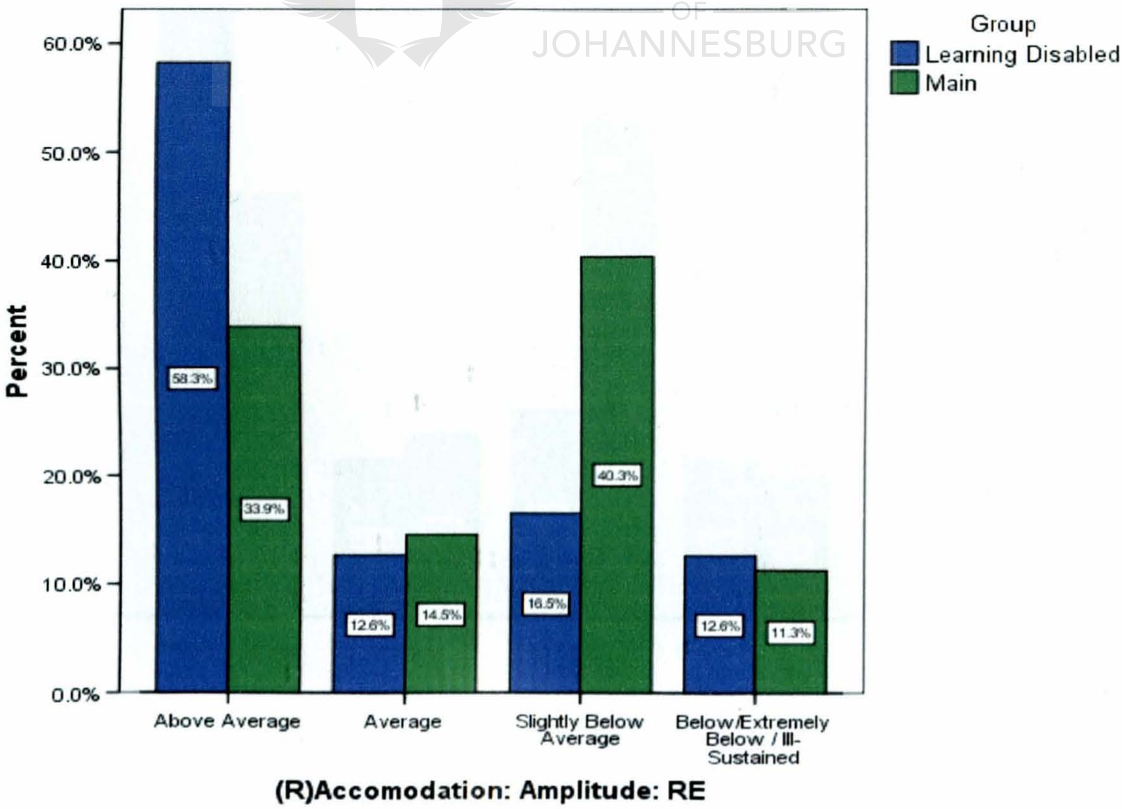

Figure 5.11: Bar graph showing the relationship between the groups and accommodation amplitude (RE)

Table 5.42:

The relationship between the groups accommodation and amplitude (LE)

Crosstab							
			Accommodation: Amplitude: LE				Total
			Above Average	Average	Slightly Below Average	Below/Extremely Below / Ill-Sustained	
Group	Learning disabilities	Count	62	12	18	12	104
		% within Group	59.6%	11.5%	17.3%	11.5%	100.0%
	Main	Count	20	8	27	5	60
		% within Group	33.3%	13.3%	45.0%	8.3%	100.0%
Total		Count	82	20	45	17	164
		% within Group	50.0%	12.2%	27.4%	10.4%	100.0%

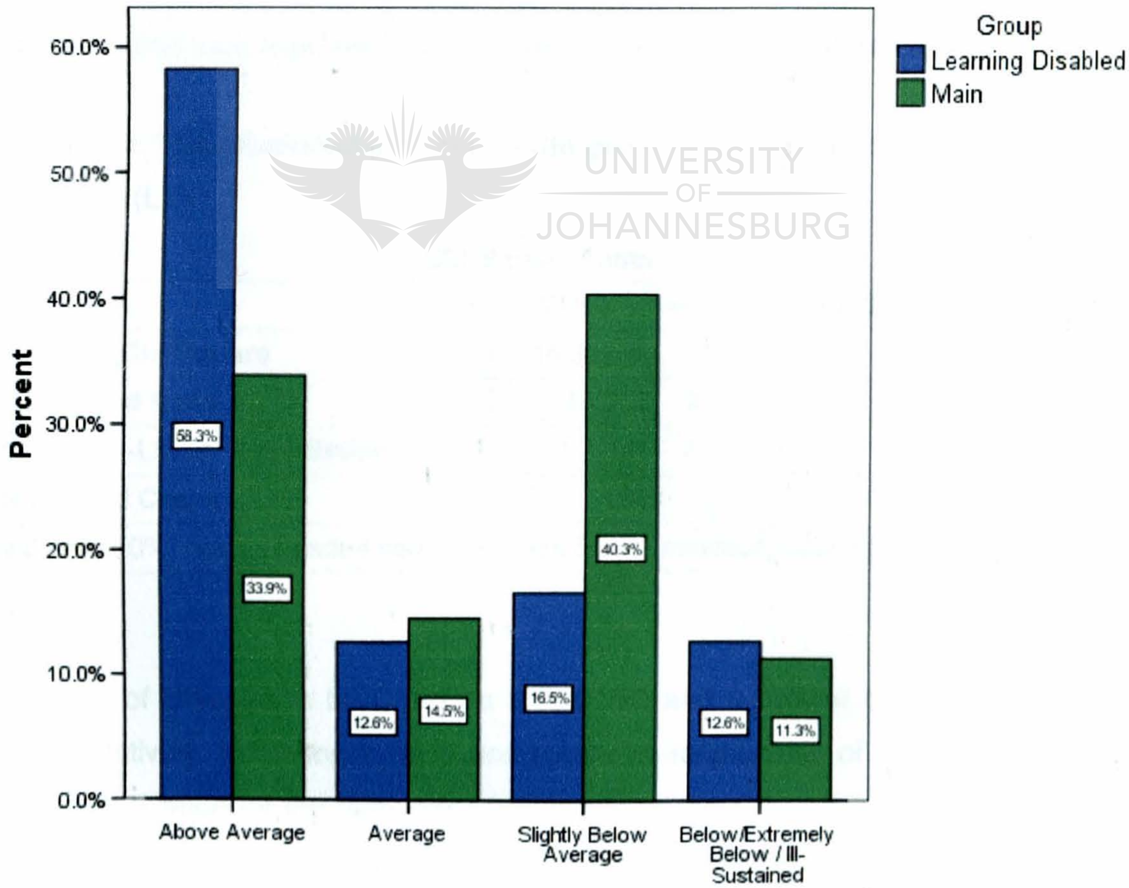

Figure 5.12: Bar graph showing the relationship between the groups and accommodation amplitude (LE)

The Pearson Chi-Square test calculated a p-value of 0.04 and 0.01 for the right and left eye respectively, and thus leading to the rejection of the null hypothesis. In rejecting the null hypothesis a conclusion is therefore reached that a statistically significant relationship exist between poor amplitudes of accommodation for the right and left eye and the mainstream group (see Tables 5.43 and 5.44).

Table 5.43: The relationship between the groups and accommodation amplitude (RE):

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	13.473(a)	3	.004
Likelihood Ratio	13.377	3	.004
Linear-by-Linear Association	6.484	1	.011
N of Valid Cases	165		
a 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.52.			

Table 5.44: The relationship between the groups and the accommodation amplitude (LE)

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	16.368(a)	3	.001
Likelihood Ratio	16.205	3	.001
Linear-by-Linear Association	7.197	1	.007
N of Valid Cases	164		
a 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.22.			

Measures of association by Cramer's V is 0.286 and 0.316 for the right and left eye respectively, indicating a weak and moderate relationship of poor amplitudes of accommodation for the right and left eyes respectively in the mainstream group (see Tables 5.45 and 5.46 below). Although the significance of this relationship indicates that children with learning disabilities are more likely to present with poor amplitudes of the right and left eyes, it appears that for the right eye the relationship is due to chance since the relationship is weak (0.286) as determined by Cramer's V.

Thus it cannot be safely concluded that children from the learning disabled group have poor amplitudes of the right eye, but for the left eye the conclusion of a significant relationship can be drawn.

Table 5.45: The relationship between the groups and amplitudes of accommodation (RE)

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.286	.004
	Cramer's V	.286	.004
N of Valid Cases		165	
a Not assuming the null hypothesis.			
b Using the asymptotic standard error assuming the null hypothesis.			

Table 5.46:

The relationship between the groups and accommodation amplitude (LE): Cramer's V test

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.316	.001
	Cramer's V	.316	.001
N of Valid Cases		164	
a Not assuming the null hypothesis.			
b Using the asymptotic standard error assuming the null hypothesis.			

5.10.3.2 The relationship between accommodation amplitude and age

For the age group of 8-10 year olds poor amplitudes for the right and left eye were found to be high 17.3% and 14.7% than in the 11-13 year olds 3.3% and 3.2% respectively (see Appendix C, Tables 9 and 12). In testing the hypothesis of independence the p-values for the right and left eye were calculated to be 0.015 and 0.062 respectively (see Appendix C, Tables 10 and 13). For the left eye no relationship was found to exist between the poor amplitudes of the left eye and the

8-10 year old age group, contrary to the right eye in which a relationship was suspected to exist since the p-value was found to be less than 0.05. Cramer's V with the value of 0.251 for the right eye revealed that the strength of the relationship between the right eye amplitudes with the 8-10 year old age group is weak (see Appendix C, Table 11).

5.10.3.3 The relationship between amplitude of accommodation and gender

Below normal amplitudes were found to be more in the male respondents 40.6% and 42.7%, than in the females 33.9% and 31.4% for both the right and the left eyes respectively (see Appendix C, Tables 14 and 16). Respondents with below normal amplitudes were found to be clustered around the slightly below normal amplitudes, with the percentage of extremely below normal amplitudes being 15.6% and 14.6% for the right and left eyes respectively in the males. The p-values for both the right and the left eyes were found to be 0.460 and 0.119 respectively, which are more than 0.05 indicating that a relationship does not exist between poor amplitudes of accommodation for the right and left eyes and the males (see Appendix C, Tables 15 and 17).

5.11 THE VERGENCE SYSTEM

In this section the relationships between vergence system and the learner groups will be evaluated by means of Pearson's Chi-square test and the Cramer's V measures of association.

5.11.1 Cover test

The cover test was performed on 190 learners and only 2 respondent's results were not considered due to poor responses. Respondents with abnormal cover test results at distance and near were less (9% and 11%) in the learning disabled and the mainstream group respectively, compared to the normal cover test results. A high percentage 95.3% and 94.2% of respondents from both groups had normal cover test results for distance and near. The percentage of respondents with below normal cover test results at distance and near were found to be high 6.4%

and 8.2% respectively, in the learning disabled than the 2.5% in the mainstream group (see Tables 5.47 and 5.48 below).

Table 5.47: The relationship between the groups and cover test at 6m

Crosstab					
			Cover Test 6m		Total
			Normal	Abnormal	
Group	Learning disabilities	Count	103	7	110
		% within Group	93.6%	6.4%	100.0%
	Main	Count	78	2	80
		% within Group	97.5%	2.5%	100.0%
Total		Count	181	9	190
		% within Group	95.3%	4.7%	100.0%

The bar graph below demonstrates a high percentage of normal cover test findings in both the learning disabled and the mainstream group. The bar graph below also clearly shows the mainstream group have a higher percentage of normal cover test findings, than the abnormal cover test compared to the learning disabled group. The same is also displayed for near cover test findings in Figure 5.14 below.

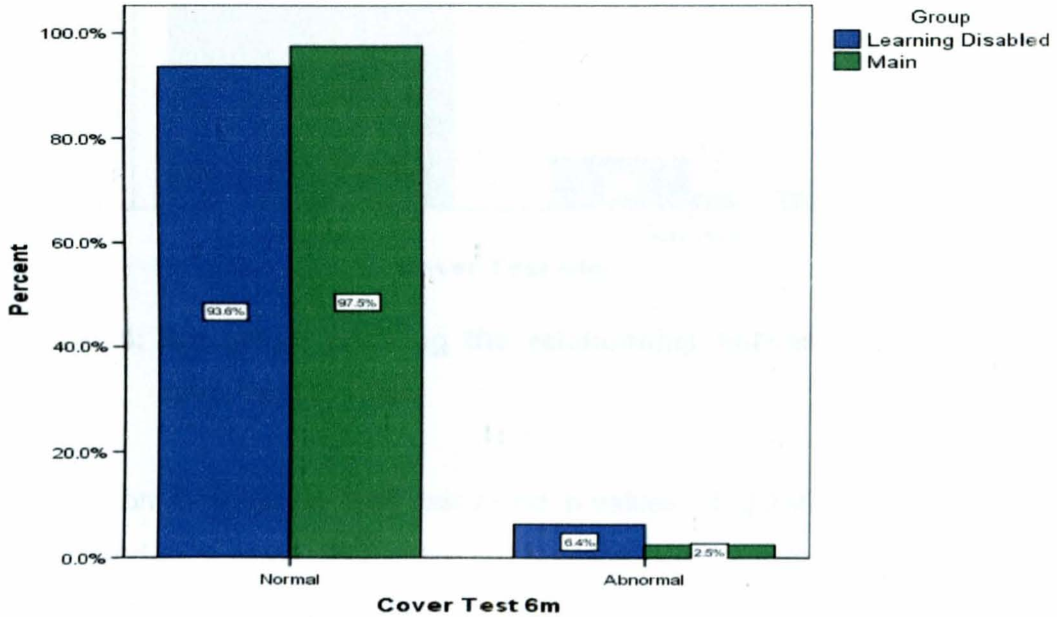

Figure 5.13: Bar graph showing the relationship between the groups and cover test @ 6m

Table 5.48: The relationship between the groups and cover test at 40cm

Crosstab

			Cover Test 40cm		Total
			Normal	Abnormal	
Group	Learning disabled	Count	101	9	110
		% within Group	91.8%	8.2%	100.0%
	Main	Count	78	2	80
		% within Group	97.5%	2.5%	100.0%
Total		Count	179	11	190
		% within Group	94.2%	5.8%	100.0%

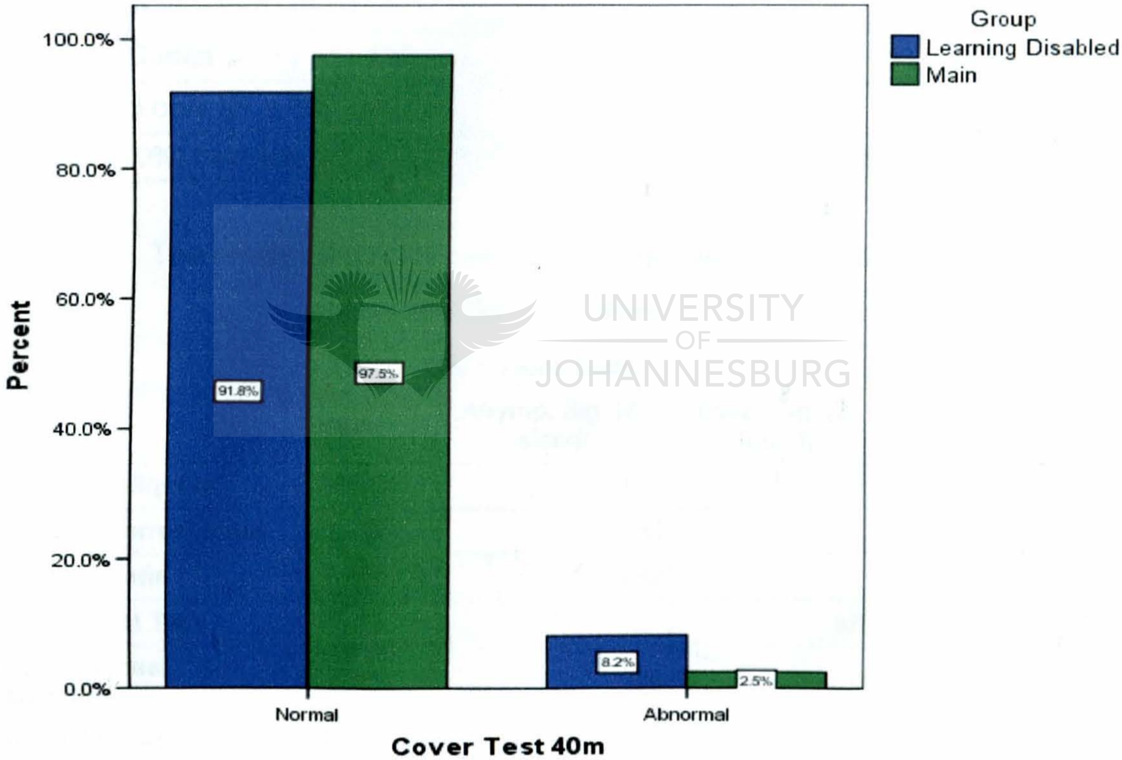

Figure 5.14: Bar graph showing the relationship between the groups and cover test @ 40cm

The Pearson Chi-Square test calculated p-values of 0.216 and 0.098 for the distance and near cover test respectively which is greater than 0.05 (see Tables 5.49 and 5.50 below). Therefore leading to the acceptance of the null hypothesis, and the conclusion that no relationship exists between abnormal cover test results for distance and near and the learning disabled group.

Table 5.49: The relationship between the groups and cover test at 6m:

Chi-Square Tests

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.532(b)	1	.216		
Continuity Correction(a)	.796	1	.372		
Likelihood Ratio	1.649	1	.199		
Fisher's Exact Test				.307	.188
Linear-by-Linear Association	1.524	1	.217		
N of Valid Cases	190				
a Computed only for a 2x2 table					
b 1 cells (25.0%) have expected count less than 5. The minimum expected count is 3.79.					

Table 5.50: The relationship between the groups and cover test at 40cm:

Chi-Square Tests

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.741(b)	1	.098		
Continuity Correction(a)	1.799	1	.180		
Likelihood Ratio	3.025	1	.082		
Fisher's Exact Test				.123	.087
Linear-by-Linear Association	2.727	1	.099		
N of Valid Cases	190				
a Computed only for a 2x2 Table					
b 1 cells (25.0%) have expected count less than 5. The minimum expected count is 4.63.					

5.11.2 Near point of convergence

5.11.2.1 The relationship between reduced near point of convergence and the learner groups

In the two groups combined (the learning disabled and the mainstream) 25% were found to have reduced nearpoint of convergence for both break and recovery. The percentage of respondents with below normal near point of convergence was found to be the same (25%) in both the learning disabled and the mainstream groups (see Appendix D, Tables 1 to 4).

5.11.2.2 The relationship between reduced near point of convergence and gender

The percentage of respondents with reduced near point of convergence for break was found to be more in the males 25.9% than in females 22.8% (see Table 5.51 below). Regarding below normal near point of convergence for recovery no difference was found between the males and female respondents.

Table 5.51: The relationship between the nearpoint of convergence (break) and gender

Crosstab

			NPC: Break		Total
			Normal	Abnormal	
Sex	Male	Count	80	28	108
		% within Sex	74.1%	25.9%	100.0%
	Female	Count	61	18	79
		% within Sex	77.2%	22.8%	100.0%
Total		Count	141	46	187
		% within Sex	75.4%	24.6%	100.0%

The Pearson Chi Square test calculated the p-value of 0.622, which indicated that no relationship exists between gender (males) and below normal near point of convergence (see Table 5.52 below).

Table 5.52: The relationship between the near point of convergence (break) and gender

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.243(b)	1	.622		
Continuity Correction(a)	.103	1	.748		
Likelihood Ratio	.244	1	.621		
Fisher's Exact Test				.731	.376
Linear-by-Linear Association	.241	1	.623		
N of Valid Cases	187				

a Computed only for a 2x2 Table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 19.43.

5.11.3 Smooth vergences

Of the 192 respondents only 161 and 160 were evaluated for both the base-in and base-out vergences respectively (see Appendix D, Table 5 & Table 5.53 below). Poor base-in and base-out vergences were found in 16.1% and 35% respectively for both groups combined.

5.11.3.1 The relationship between the learner groups and base-in vergences

In evaluating the base-in vergences in both groups of the 16.1% with low reserves, respondents from the mainstream were found to have a high percentage 21.5% than the 11% in learning disabled group (see Appendix D, Table 5). The Chi Square test calculated a p-value of 0.087 which is greater than 0.05 (see Appendix D, Table 6). Resulting in the acceptance of the null hypothesis and therefore leading to the conclusion that no relationship exists between poor base-in vergences and the mainstream group.

5.11.3.2 The relationship between the groups and base-out vergences

The percentage of respondents with poor base-out vergences was found to be high (46.8%) in the mainstream than 23.5% in the learning disabled group. The percentage of respondents with normal base-out vergences was found to be high in the learning disabled (76.5%), than in the mainstream group (53.2%) (see Table 5.53 below).

Table 5.53: The relationship between the groups and base-out vergences

Crosstab

			Step Vergences: BO		Total
			Normal	Poor	
Group	Learning disabled	Count	62	19	81
		% within Group	76.5%	23.5%	100.0%
	Main	Count	42	37	79
		% within Group	53.2%	46.8%	100.0%
Total		Count	104	56	160
		% within Group	65.0%	35.0%	100.0%

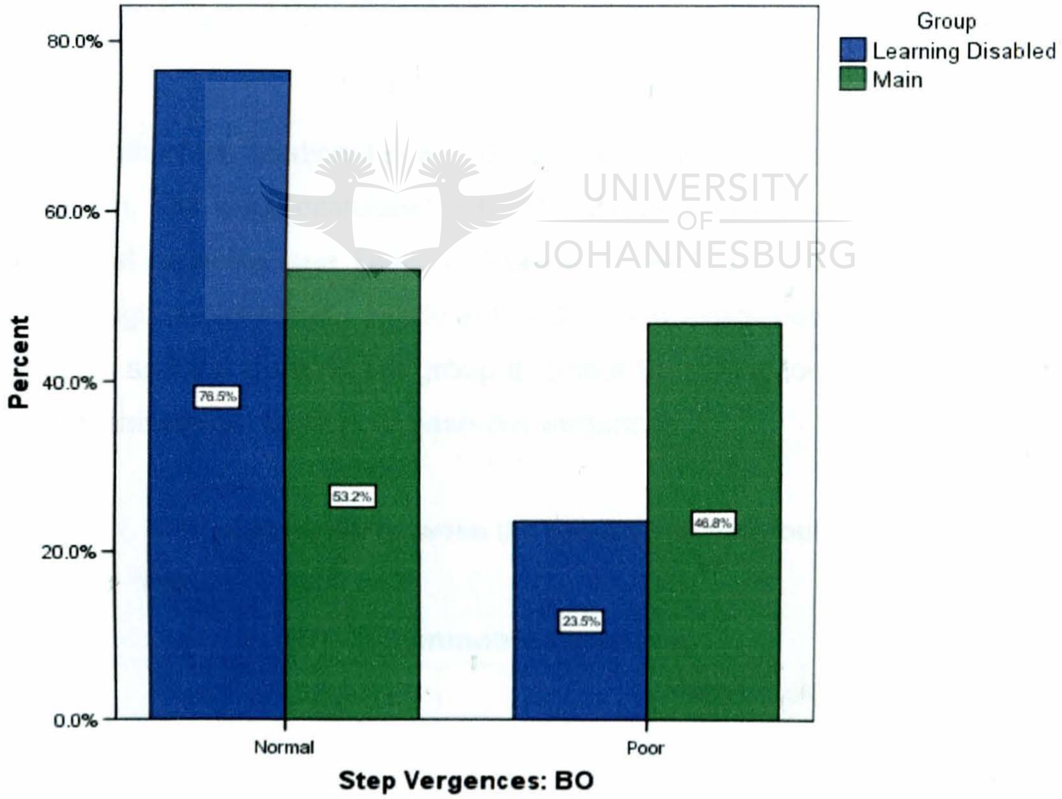

Figure 5.15: Bar graph showing the relationship between the groups and step vergences (BO)

To test the hypothesis of independence between these two variables, Chi-Square test calculated a p-value of 0.002 less than the 0.05 (see Table 5.54 below).

Therefore leading to the conclusion that statistically significant relationship exits between the poor base-out vergence and the mainstream group.

Table 5.54: The relationship between the groups and base-out vergences

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	9.608(b)	1	.002		
Continuity Correction(a)	8.608	1	.003		
Likelihood Ratio	9.735	1	.002		
Fisher's Exact Test				.003	.002
Linear-by-Linear Association	9.548	1	.002		
N of Valid Cases	160				
a Computed only for a 2x2 Table					
b 0 cells (.0%) have expected count less than 5. The minimum expected count is 27.65.					

The strength of the relationship was determined using the Cramer's V measure of association. The value calculated is 0.245 indicating a weak relationship between the nominal variables (see Table 5.55 below). Therefore leading to the conclusion that although a statistically significant relationship exists between poor base-out vergences and the mainstream group it cannot be safely concluded that children from the mainstream have poor base-out vergences.

Table 5.55: The relationship between the groups and base-out vergences: Cramer's V Test

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.245	.002
	Cramer's V	.245	.002
N of Valid Cases		160	
a Not assuming the null hypothesis.			
b Using the asymptotic standard error assuming the null hypothesis.			

5.11.3.3 The relationship between the base-out vergences and age

The percentage of respondents with poor base-out vergences was found to be high 45% in the 8-10-year-olds (see Appendix D Table 7). Fisher's Exact test determined a p-value of 0.001 which is less than 0.05, and therefore the conclusion that a statistically significant relationship exits between the two variables (see Appendix D Table 8). Measures of association determined using the Cramer's V calculated a value of 0.271 indicating a weak relationship between the nominal variables (see Appendix D Table 9). Therefore it cannot be safely concluded that children from the mainstream have poor base-out vergences.

5.11.4 Vergence facility

5.11.4.1 The relationship between vergence facility and the groups

This test was performed on only 177 respondents instead of 192, due to poor responses and the respondents not understanding the test. The percentage of respondents with poor vergence facility was found to be 19.2% for both groups combined. Of the 19.2% with poor vergences, 20.5% was from the mainstream and 18.3% from the learning disabled group (see Table 5.56 below)

Table 5.56: The relationship between the groups and vergence facility

Crosstab

			Vergence Facility			Total
			Above Average	Normal	Poor	
Group	Learning disabled	Count	53	32	19	104
		% within Group	51.0%	30.8%	18.3%	100.0%
	Main	Count	12	46	15	73
		% within Group	16.4%	63.0%	20.5%	100.0%
Total		Count	65	78	34	177
		% within Group	36.7%	44.1%	19.2%	100.0%

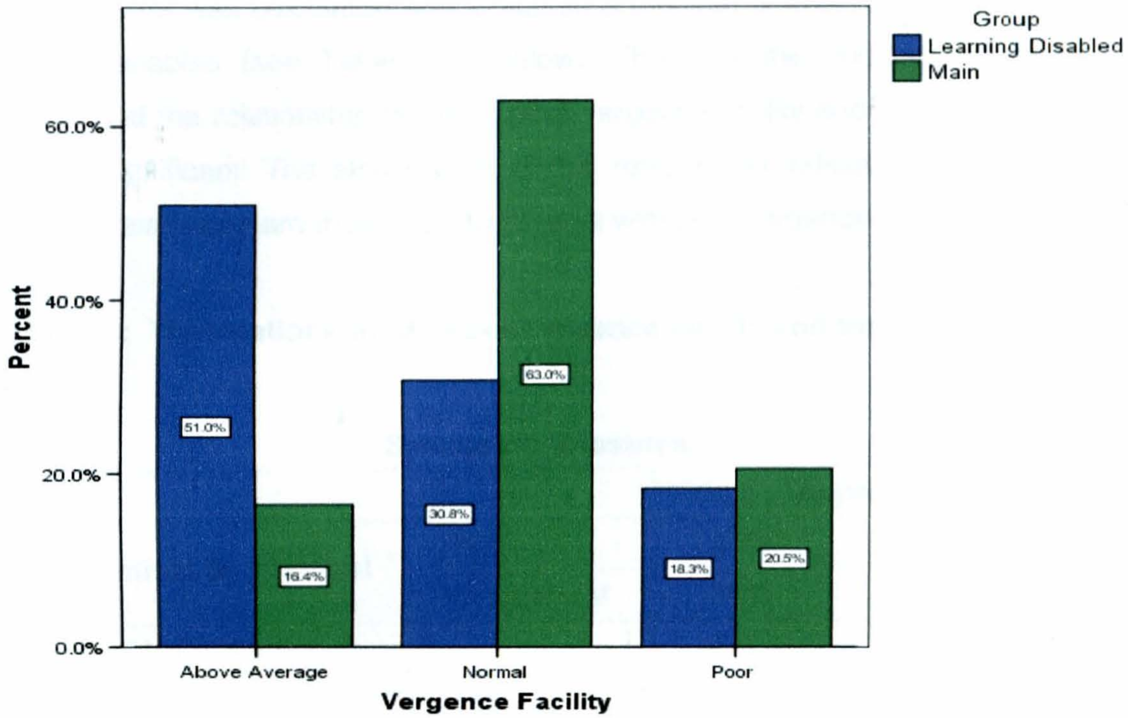

Figure 5.16: Bar graph showing the relationship between the learner groups and vergence facility

The Pearson Chi-Square test on the relationship between poor vergence facility and the mainstream group calculated a p-value of 0.00, less than the 0.05 resulting in the rejection of the null hypothesis (see Table 5.57 below). Therefore indicating that a statistically significant relationship exits between the poor vergence facility and the mainstream group.

Table 5.57: The relationship between the learner groups and vergence facility:

Chi-Square Tests			
	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	24.157(a)	2	.000
Likelihood Ratio	25.468	2	.000
Linear-by-Linear Association	10.927	1	.001
N of Valid Cases	177		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 14.02.

The strength of the relationship was determined using the Cramer's V test and a value of 0.369 was calculated and indicated a medium relationship between the nominal variables (see Table 5.58 below). Therefore the conclusion can be reached that the relationship between poor vergence facility and the mainstream group is significant. The significance of this relationship indicates that children from the mainstream are most likely to present with poor vergence facility.

Table 5.58: The relationship between vergence facility and the learner groups

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.369	.000
	Cramer's V	.369	.000
N of Valid Cases		177	
a Not assuming the null hypothesis.			
b Using the asymptotic standard error assuming the null hypothesis.			

5.11.4.2 The relationship between vergence facility and gender

Of the 177 respondents who had their visual facility evaluated only one subject's gender was not recorded. There were 100 male respondents and 76 female respondents who were evaluated. Female respondents were found to have a high percentage (22.4%) of poor vergence facilities than the males with 17% (see Appendix D, Table 12). The Pearson Chi-Square test calculated the value of 0.083 greater than 0.05, and therefore leading to acceptance of the null hypothesis (see Appendix D, Table 13). In accepting the null hypothesis we thus conclude that no relationship exists between females and poor vergence facility.

5.11.4.3 The relationship between vergence facility and age

In this study 177 respondents had the vergence facility evaluated. In the 8-10 year-old age group 100 respondents had the vergence facility evaluated and 77 were in the 11-13 year-old-age group. Respondents in the age group of 11-13 years had a high percentage (23.7%) of poor vergence facility, compared to the 16.9% in the 8-10 year old group (see Appendix D, Table 14).

Pearson Chi-Square test as indicated in Appendix D, Table 15, determined a p-value of 0.548 leading to the acceptance of the null hypothesis. This statistical analysis therefore leads to the conclusion that no relationship exists between poor vergence facility and the 11-13 year olds.

5.12 OCULAR MOTILITIES

In this section potential relationships between ocular motilities and the two groups (the learning disabled and the mainstream group) will be evaluated by means of Pearson's Chi-square test and the Cramer's V measures of association.

5.12.1 Saccadic eye movements

5.12.1.1 The relationship between the groups and saccadic eye movements

In the evaluations of saccadic eye movements, of the 192 respondents involved in the study only one child was not evaluated. Moderate to large head movements were found to be 13.6%, poor accuracy 11% and poor ability 12% (see Appendix E, Table 1), in the two groups combined.

The cross tabulation (Table 5.59 below) shows a high percentage (16.3%) of moderate to large head movements in the mainstream than in the learning disabled group (11.7%).

Table 5.59:

The relationship between the groups and saccadic (head) eye movements

Cross tabulation						
			(R)Saccadic: Head			Total
			1-3	4	5	
Group	Learning disabled	Count	13	42	56	111
		% within Group	11.7%	37.8%	50.5%	100.0%
	Main	Count	13	32	35	80
		% within Group	16.3%	40.0%	43.8%	100.0%
Total		Count	26	74	91	191
		% within Group	13.6%	38.7%	47.6%	100.0%

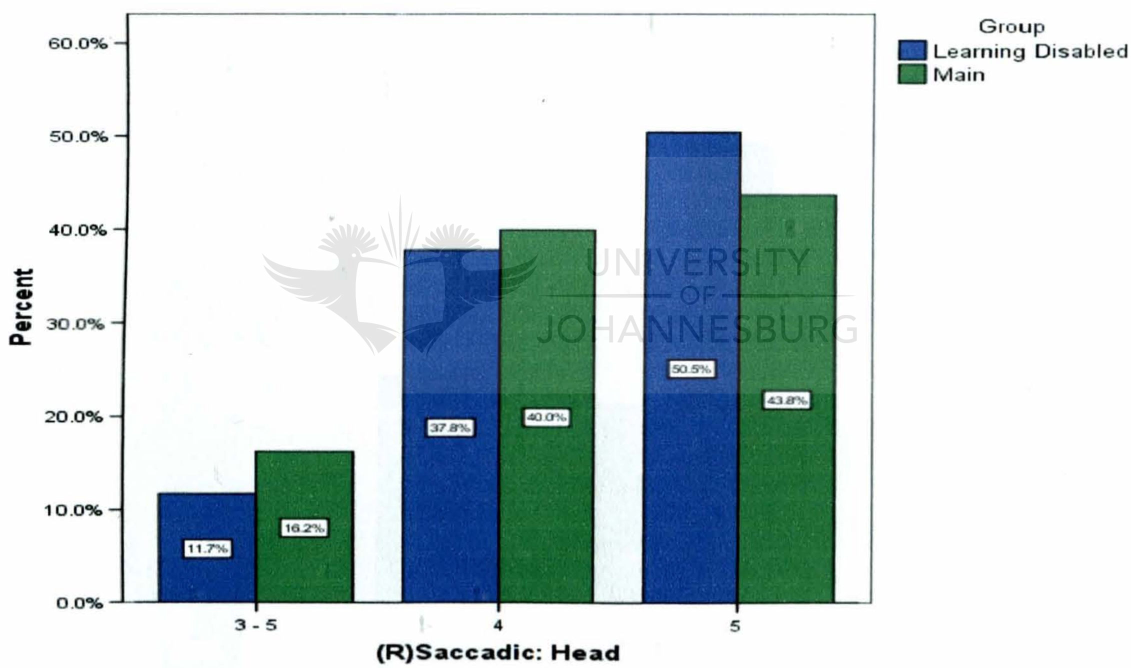

Figure 5.17: Bar graph showing the relationship between saccadic (head) and groups

The percentage of respondents with poor accuracy of saccadic eye movements was found to be high in the learning disabled group (15.3%) as indicated in the Table 5.60 below.

Table 5.60: The relationship between the learner groups and saccadic (Accuracy)

Crosstab

			(R)Saccadic: Accuracy			Total
			3 - 5	4	5	
Group	Learning disabled	Count	17	49	45	111
		% within Group	15.3%	44.1%	40.5%	100.0%
	Main	Count	4	16	60	80
		% within Group	5.0%	20.0%	75.0%	100.0%
Total		Count	21	65	105	191
		% within Group	11.0%	34.0%	55.0%	100.0%

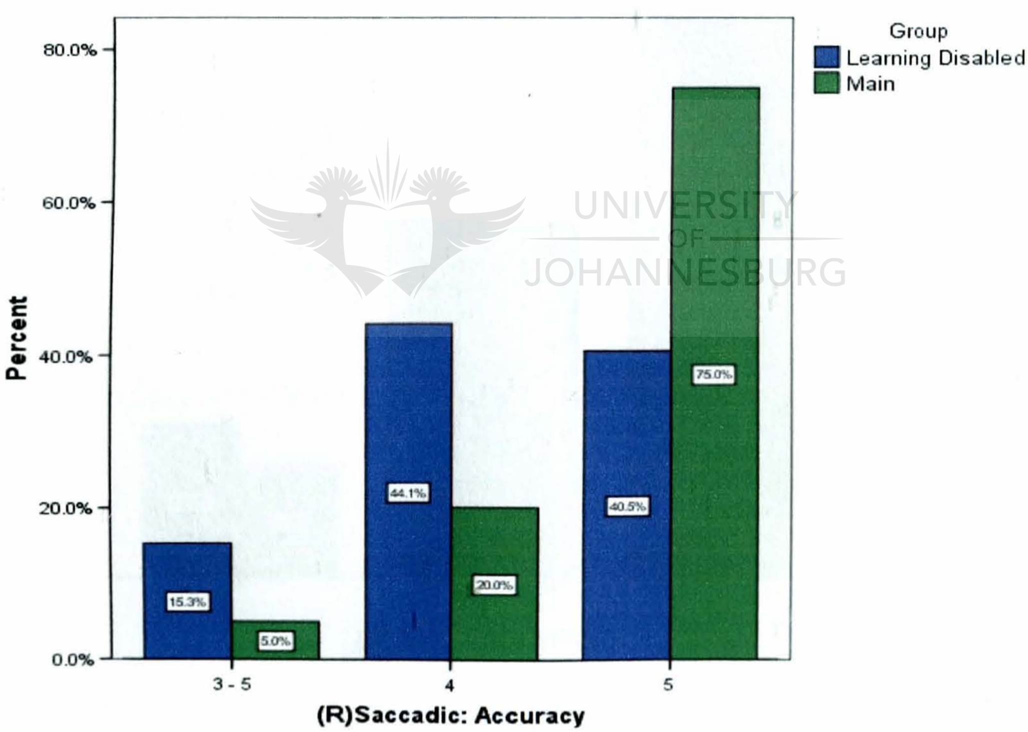

Figure 5.18: Bar graph showing the relationship between the groups and saccadic (accuracy)

The percentage of respondents with poor ability to perform saccadic eye movements was found to be high 13.5% in the learning disabled group as indicated in the Table 5.61 below.

Table 5.61: The relationship between the groups and saccadic (Ability)

Crosstab

			(R)Saccadic: Ability			Total
			3 - 5	4	5	
Group	Learning disabled	Count	15	35	61	111
		% within Group	13.5%	31.5%	55.0%	100.0%
	Main	Count	8	25	47	80
		% within Group	10.0%	31.3%	58.8%	100.0%
Total		Count	23	60	108	191
		% within Group	12.0%	31.4%	56.5%	100.0%

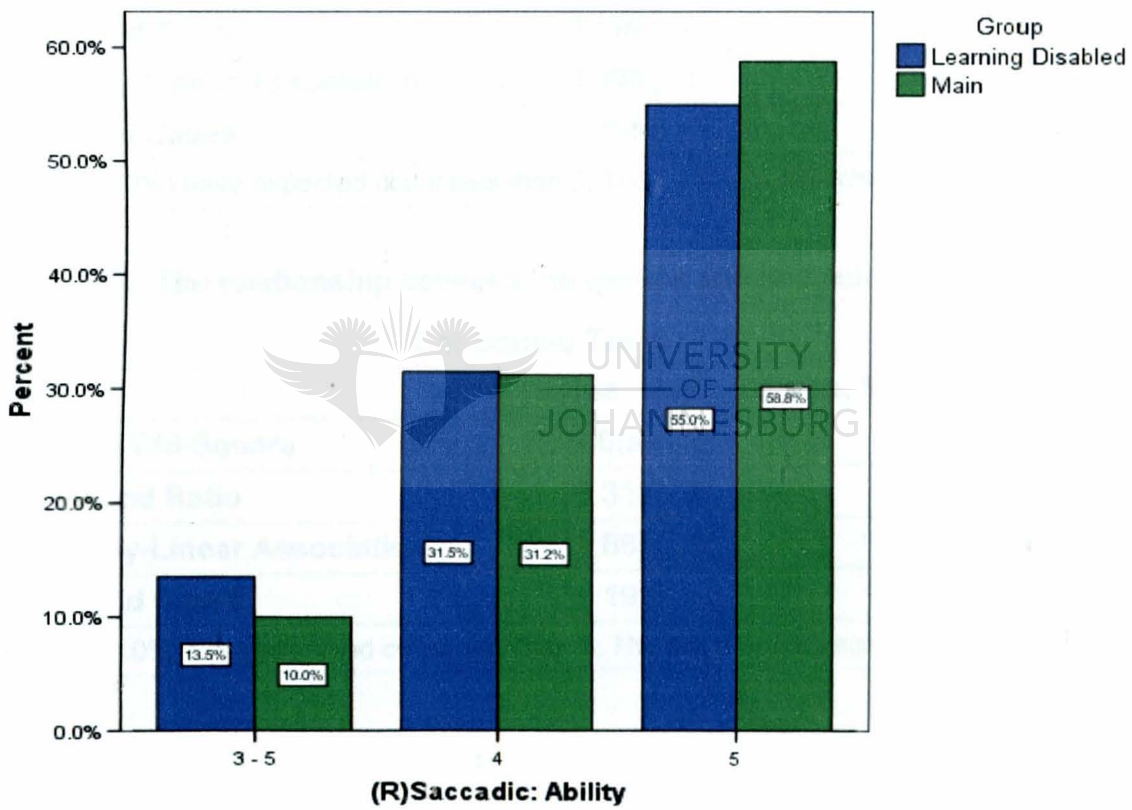

Figure 5.19: Bar graph showing the relationship between the groups and saccadic (ability)

Although a high percentage of moderate to large head movement was observed in the mainstream group, the relationship was found not to exist since the p-value calculated is 0.549 (>0.05) (see Table 5.62 below). The same applies to saccadic accuracy, although a high percentage of poor saccadic ability was observed in the learning disabled group, the relationship between the variables was found not to exist since the p-value determined is 0.742 (>0.05) (see Table 5.64 below). However a statistically significant relationship was found to exist between poor saccadic accuracy and the learning disabled group since the p-value calculated is 0.00, less than 0.05 as indicated in the Table 5.63 below.

Table 5.62: The relationship between the groups and saccadic (head) eye movements

Chi-Square Tests

	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	1.198(a)	2	.549
Likelihood Ratio	1.192	2	.551
Linear-by-Linear Association	1.176	1	.278
N of Valid Cases	191		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 10.89.

Table 5.63: The relationship between the groups and saccadic (accuracy):

Chi-Square Tests

	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	22.506(a)	2	.000
Likelihood Ratio	23.318	2	.000
Linear-by-Linear Association	19.885	1	.000
N of Valid Cases	191		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.80.

Table 5.64: The relationship between the groups and saccadic (ability)

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.596(a)	2	.742
Likelihood Ratio	.605	2	.739
Linear-by-Linear Association	.506	1	.477
N of Valid Cases	191		
a 0 cells (.0%) have expected count less than 5. The minimum expected count is 9.63.			

The strength of the relationship between poor saccadic accuracy and the learning disabled group was determined using the Cramer's V measure of association. The value calculated is 0.343 indicating a medium relationship between the nominal variables (see Table 5.65 below). Therefore leading to the conclusion that the relationship between poor saccadic accuracy and the learning disabled group is of medium effect. The significance of this relationship indicates that children from the learning disabled group are more likely to present with poor saccadic accuracy.

Table 5.65: The Relationship between the groups and saccadic (accuracy)

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	**Phi**	.343	.000
	Cramer's V	.343	.000
N of Valid Cases		191	
a Not assuming the null hypothesis.			
b Using the asymptotic standard error assuming the null hypothesis.			

Table 5.66: The relationship between the groups and saccadic (ability)

Symmetric Measures			
		Value	**Approx. Sig.**
Nominal by Nominal	**Phi**	.056	.742
	Cramer's V	.056	.742
N of Valid Cases		191	
a Not assuming the null hypothesis.			
b Using the asymptotic standard error assuming the null hypothesis.			

5.12.1.2 The relationship between saccadic eye movements vs. gender and age

Since the relationships between poor saccadic eye movements, gender and age were found to be insignificant the researcher will only report on the results briefly.

The role of gender and age towards poor saccadic accuracy was determined. Of the 192 respondents participating in the study only 190 had their gender recorded. A high percentage 12.8% and 13.6% of poor saccadic accuracy was determined in males and in the 11-13 year olds respectively (see Appendix E, Tables 2 and 4). No relationship was found to exist between poor saccadic accuracy and males as well as with the 11-13 year olds, since the p-values determined were more than 0.05 (0.534 and 0.157 respectively) using Chi-Square tests (see Appendix E, Tables 3 and 5).

5.12.2 Pursuit eye movements

Of the 192 respondents evaluated only one child was not evaluated. The evaluations revealed that 12% of the respondents in both groups combined had moderate to large head movements,16.2% and 11% had poor accuracy and ability respectively (see Appendix E, Table 1).

5.12.2.1 The relationship between learner groups and pursuit eye movements

The following discussion is about the relationship between the group's three important aspects of pursuits that were evaluated, including head movements, accuracy and ability.

- **The groups and pursuit (head)**

In the mainstream school 17.5% respondents had moderate to large head movements when pursuit eye movements were evaluated, more than 8.1% respondents in the school of the learning disabled (see Table 5.67 below).

Table 5.67: The relationship between the groups and pursuits (head)

Crosstab

			(R)Pursuits: Head			Total
			3 - 5	4	5	
Group	Learning disabled	Count	9	50	52	111
		% within Group	8.1%	45.0%	46.8%	100.0%
	Main	Count	14	35	31	80
		% within Group	17.5%	43.8%	38.8%	100.0%
Total		Count	23	85	83	191
		% within Group	12.0%	44.5%	43.5%	100.0%

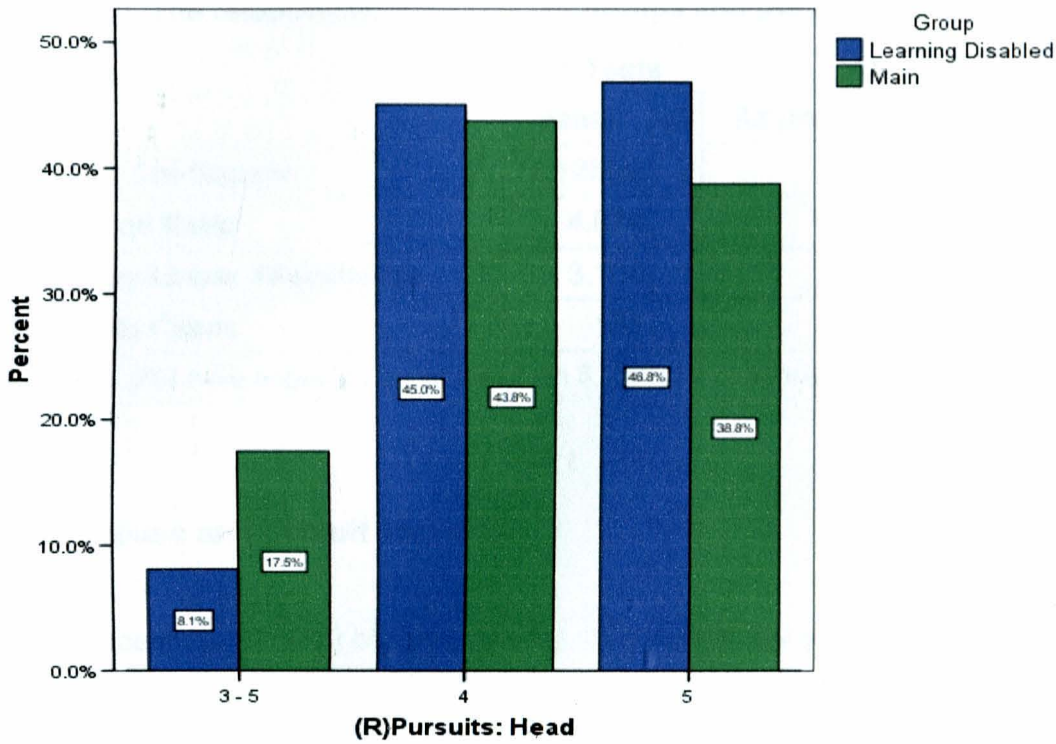

Figure 5.20: Bar graph showing the relationship between the groups and pursuit (head)

Pearson Chi-Square test for the hypothesis is 0.127 which is not less than 0.05, thus the null hypothesis is accepted leading to the conclusion that the variables are independent of each other (see Table 5.68 below). Thus we can safely conclude that moderate and large head movements when pursuits are performed are not associated with the mainstream group. Although the percentage of respondents with moderate to large head movements is high in the mainstream school it can be due to chance.

Table 5.68: The relationship between the groups and pursuit (head):

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.125(a)	2	.127
Likelihood Ratio	4.074	2	.130
Linear-by-Linear Association	3.100	1	.078
N of Valid Cases	191		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 9.63.

- **The groups and pursuit accuracy**

A high percentage (21.6%) of respondents with poor accuracy in the learning Disabled group was found than the 8.8% in the mainstream group (see Table 5.69 below).

Table 5.69: The relationship between the groups and pursuits (accuracy)

Crosstab

			(R)Pursuits: Accuracy			Total
			3 - 5	4	5	
Group	**Learning disabled**	**Count**	24	48	39	111
		% within Group	21.6%	43.2%	35.1%	100.0%
	Main	**Count**	7	23	50	80
		% within Group	8.8%	28.8%	62.5%	100.0%
Total		**Count**	31	71	89	191
		% within Group	16.2%	37.2%	46.6%	100.0%

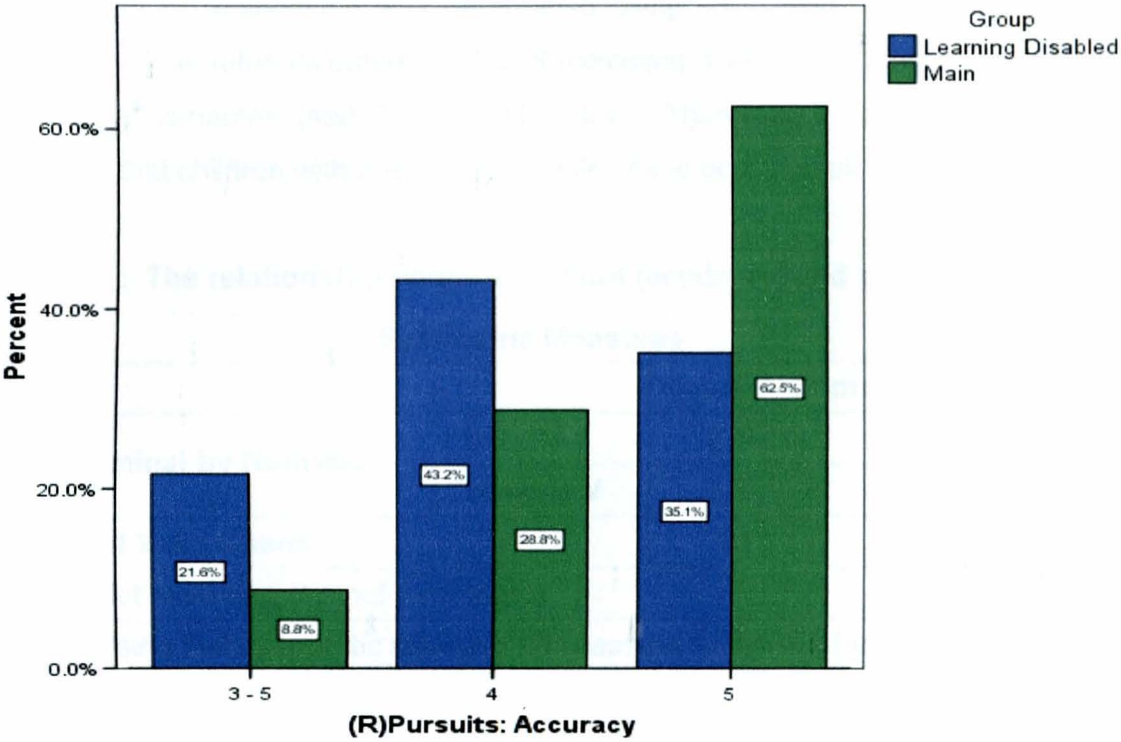

Figure 5.21: Bar graph showing the relationship between the groups and pursuit (accuracy)

The Pearson Chi-square Test determined a p-value of 0.00 which is less than 0.05 (see Table 5.70 below). This finding therefore leads to the rejection of the null hypothesis and the conclusion that a statistically significant relationship exits between poor accuracy of the pursuit eye movements and the learning disabled group.

Table 5.70: The relationship between the groups and pursuit (accuracy):

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	14.845(a)	2	.001
Likelihood Ratio	15.161	2	.001
Linear-by-Linear Association	13.968	1	.000
N of Valid Cases	191		
a 0 cells (.0%) have expected count less than 5. The minimum expected count is 12.98.			

The strength of relationship was determined using the Cramer's V measure of association. The value calculated is 0.279 indicating a weak relationship between the nominal variables (see Table 5.71 below). Therefore it cannot be safely concluded that children with a learning disability have poor pursuit accuracy.

Table 5.71: The relationship between pursuit (accuracy) and groups:

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.279	.001
	Cramer's V	.279	.001
N of Valid Cases		191	
a Not assuming the null hypothesis.			
b Using the asymptotic standard error assuming the null hypothesis.			

- **The groups and pursuit (ability)**

Poor ability of the pursuit eye movements was found to be more prevalent (12.5%) in the mainstream than the 9.9% in the learning disabled group (see Table 5.72 below).

Table 5.72: The relationship between the groups and pursuit (ability)

Crosstab

			Pursuits: Ability			Total
			3 - 5	4	5	
Group	Learning disabled	Count	11	37	63	111
		% within Group	9.9%	33.3%	56.8%	100.0%
	Main	Count	10	28	42	80
		% within Group	12.5%	35.0%	52.5%	100.0%
Total		Count	21	65	105	191
		% within Group	11.0%	34.0%	55.0%	100.0%

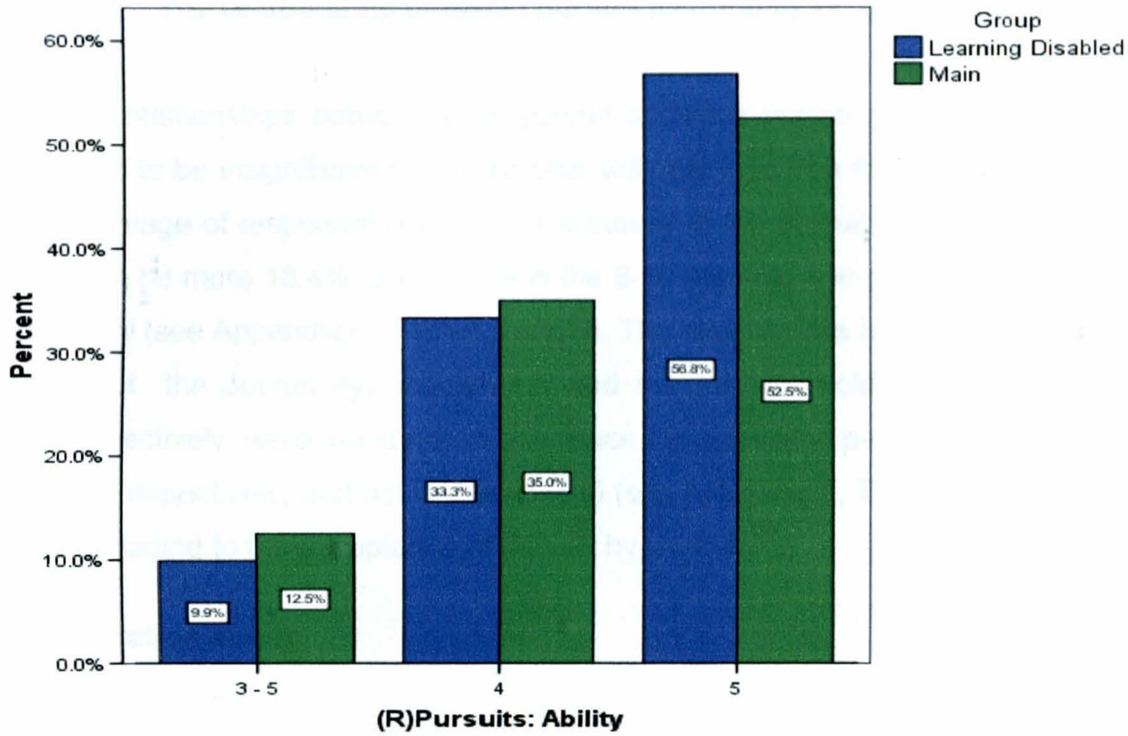

Figure 5.22: Bar graph showing the relationship between the groups and pursuit (ability)

Pearson Chi-Square test was thus calculated to be 0.789 which is greater than p-value of 0.05 (see Table 5.73). The null hypothesis is accepted, and the conclusion is reached that no relationship exists between poor accuracy of the pursuit eye movements and the mainstream school.

Table 5.73: The relationship between pursuit (ability) and groups

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.475(a)	2	.789
Likelihood Ratio	.473	2	.790
Linear-by-Linear Association	.465	1	.495
N of Valid Cases	191		
a 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.80.			

5.12.2.2 The relationship between pursuit (accuracy) vs. gender and age

Since the relationships between poor pursuit accuracy versus gender and age were found to be insignificant the researcher will only report on the results briefly. The percentage of respondents with poor accuracy of the pursuit eye movements as found to be more 18.4%, and 18.3% in the 8-10 year-old age group and males respectively (see Appendix E, Tables 7 and 9). The relationships between the poor accuracy of the pursuit eye movements and the 8-10 year-old-age group and males respectively, were found not to exist since the calculated p-values are 0.295 and 0.656 respectively, and not less than 0.05 (see Appendix E, Tables 8 and 10), therefore leading to the acceptance of the null hypothesis.

5.12.3 Fixation ability

5.12.3.1 The relationship between the learner groups and fixation ability

Of the 192 respondents only one subject was not evaluated, and from the two groups only 8.9% had borderline and weak fixation ability. From the 8.9% a high percentage 12.5% of respondents with borderline and weak fixation ability was found in the mainstream group than the 6.3% from the learning disabled group (see Table 5.74 below).

Table 5.74:

The relationship between the groups and fixation ability

Crosstab

			Motility: Fixation			Total
			Weak / Adequate	Strong	Very Strong	
Group	Learning disabilities	Count	7	64	40	111
		% within Group	6.3%	57.7%	36.0%	100.0%
	Main	Count	10	24	46	80
		% within Group	12.5%	30.0%	57.5%	100.0%
Total		Count	17	88	86	191
		% within Group	8.9%	46.1%	45.0%	100.0%

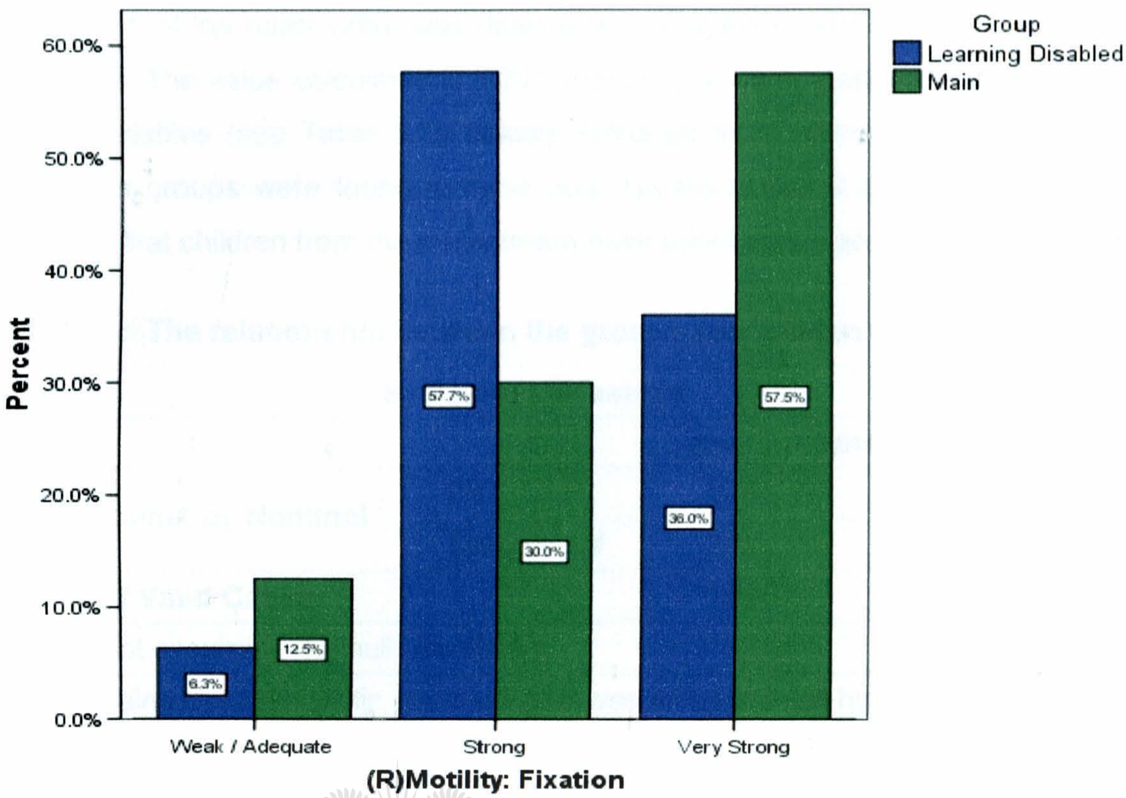

Figure 5.23: Bar graph showing the relationship between fixation ability and groups

The hypothesis of independence was tested using the Pearson Chi-Square test which calculated a p-value of 0.001 (see Table 5.75 below). This value is smaller than the p-value of 0.05 thus leading to the rejection of the null hypothesis, and the conclusion that a statistically significant relationship exits between poor fixation ability and the mainstream school.

Table 5.75: The relationship between the groups and fixation ability

Chi-Square Tests			
	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	14.480(a)	2	.001
Likelihood Ratio	14.764	2	.001
Linear-by-Linear Association	.520	1	.471
N of Valid Cases	191		
a 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.12.			

The strength of the relationship was determined using the Cramer's V measure of association. The value calculated is 0.275 indicating a weak relationship between the two variables (see Table 5.76 below). Although more respondents from the mainstream groups were found to have poor fixation ability, it cannot be safely concluded that children from the mainstream have poor fixation ability.

Table 5.76: The relationship between the groups and fixation ability

Symmetric Measures			
		Value	**Approx. Sig.**
Nominal by Nominal	**Phi**	.275	.001
	Cramer's V	.275	.001
N of Valid Cases		191	
a Not assuming the null hypothesis.			
b Using the asymptotic standard error assuming the null hypothesis.			

5.12.3.2 The relationship between fixation ability and gender

The percentage of respondents with poor fixation ability was found to be almost the same 8.3% for the males and 8.4% for females (see Appendix E, Table 12). Since the p-value is 0.075 (> 0.05) we accept the null hypothesis of independence. Thus leading to the conclusion that poor fixation ability is independent of gender (see Appendix E, Table 13).

5.12.3.3 The relationship between fixation ability and age

A high percentage 11.2% of respondents with poor fixation was found in the 8-10 year olds (see Appendix E, Table 14). The p-value determined by the Pearson Chi-Square test is 0.045 (< 0.05) (see Appendix E, Table 15). Thus leading to the rejection of the null hypothesis, and the conclusion that a relationship might exist between poor fixation ability and the 8-10 year olds. Measures of association were determined using the Cramer's V test. The value calculated is 0.180 indicating a weak relationship between the two variables (see Appendix E, Table 16). Thus it cannot be safely concluded that children in the 8-10 year old group have poor fixation ability.

5.12.4 Ocular health status

Regarding the ocular health status the results of our findings were not analysed statistically due to the fact that out of the 192 respondents only one subject from the school of the learning disabled presented with amblyopia related to pathology. Therefore these findings were excluded since they were found to be insignificant.

5.13 SUMMARY OF THE RESULTS

1. The learning disabled group was composed of more males than females, and the mainstream school was composed of more females than males. The relationship between the variables was statistically significant (p-value <0.05). However a weak relationship was determined between these variables, therefore we cannot safely conclude that an association exists between males and the learning disabled school and between females and the mainstream school.

2. The respondents were divided into two age groups of 8-10 and 11-13-year-olds. An association was found to exist (p-value >0.05) between the 8-10-year-olds in the mainstream school, and the 11-13-year-olds in the school of the learning disabled, although it is of medium effect. Thus leading to the conclusion that a moderate relationship exists between the 11-13 and 8-10-year-olds with the learning disabled and the mainstream group respectively.

   The significance of this relationship indicates that children with learning disabilities are likely to be older 11-13-years-old, compared to the mainstream group with a high percentage of 8-10-year-olds (in grades 3 & 4).It can therefore be safely concluded that children from the mainstream schools are likely to be of a younger age group compared to those from the schools of the learning disabled.

3. In the 8-10-year-old age group a high prevalence of reduced visual acuities at distance for both eyes ($p = 0.80$), reduced visual acuities at near for the right and left eyes ($p = 0.11$), reduced visual acuities at distance for both eyes ($p = 0.125$), hyperopia and mixed astigmatism ($p = 0.555$), poor

accommodation accuracy (p = 0.302) were observed. There was no association determined between the variables since the p- values were found to be less than 0.05.

4. Reduced visual acuities at distance for the right eye (p = 0.017), left eye (p = 0.025), hyperopia and astigmatism (p = 0.013), reduced base-out vergence (p = 0.001), poor amplitudes of accommodation of the right (p = 0.015) left eye (p = 0.062) and poor fixation ability (p = 0.045) were of greater prevalence in the 8-10-year-old group. However the association between the 8-10-year-old age group and reduced visual acuities at distance of the right and left eye, hyperopia, mixed astigmatism, poor amplitude of accommodation of the right eye, poor base out vergences and poor fixation ability was found to be weak. Therefore we cannot safely conclude that the 8-10-year-old group is likely to present with reduced visual acuities at distance of the right and left eye, hyperopia and astigmatism, reduced base-out vergence, poor amplitude of accommodation of the right eye and poor fixation ability.

5. There was no association between myopia and compound myopic astigmatism of the left eye (p = 0.555), high lag of accommodation (p = 0.302), poor vergence facility (p = 0.548), poor amplitude of the left eye (p = 0.062) and the 11-13-year-old age group. These were all the observed results of high prevalence in this age group (11-13-year-old). None of these comparisons were statistically significant. Myopia and compound stigmatism of the right eye (p = 0.013), were of greater prevalence in the 11-13-year-old group than in the 8-10-year-old group. These results were statistically significant, however the relationships were weak between the 11-13-year-olds and myopia, compound astigmatism, poor amplitudes of accommodation for the right eye. Therefore we cannot safely conclude that a relationship exists between the variables.

6. There was no association between poor distance visual acuities for the right (p = 0.143), left (p = 0.143) and both eyes (p = 0.102); poor near visual acuities for the right and left eye (p= 0.065); poor near visual acuities for both eyes (p =

0.650) myopia and compound myopic astigmatism (p = 0.984 and 0.852); lead of accommodation for the right and left eye (p = 0.949); poor vergence facility (p = 0.083); and poor fixation abilities (p = 0.075) and the females. However even though there a was high prevalence of these visual deficiencies in the females than in males, no statistically significant association was determined since the p-values were less than 0.05.

7. In the male respondents the visual deficiencies that were of high prevalence are the following: hyperopia (p = 0.984); mixed astigmatism (p = 0.852); poor saccadic (p = 0.534); high lag of accommodation (p = 0.949) and poor amplitudes of accommodation for the right (p = 0.460) and left (p = 0.119) eyes. However no relationships were found to exist between hyperopia, mixed astigmatism, high lag, poor amplitudes of accommodation, poor saccadic, poor pursuit accuracy and the males (p-values >0.05). Gender was therefore found not to be associated with the visual disorders evaluated in this study.

8. The mainstream group demonstrated a high prevalence of visual deficiencies including hyperopia (p = 0.006); poor base out vergences (p = 0.002); poor fixation ability (p = 0.001) and reduced amplitudes of accommodation of the right eye (p = 0.04). The relationships between the mentioned visual deficiencies and the mainstream group were found to be statistically significant (p-value<0.05), although the Cramer's V test revealed a weak association. It can therefore not be safely concluded that children from the mainstream schools are likely to present with hyperopia, poor base out vergences, poor fixation ability, and reduced amplitudes of the right eye.

9. Lead of accommodation of the right and left eyes (p = 0.000); reduced amplitudes of accommodation of the left eye (p = 0.01); and poor vergence facility (p = 0.000), were found to be of high prevalence in the mainstream than in the learning disabled group. The associations between the mentioned visual disorders and the learning disabled group were found to be statistically significant, however the relationships are of moderate size. The moderate associations therefore leads to the conclusion that children from the mainstream school are likely to be associated with lead of accommodation in

the right and left eye, reduced amplitudes of accommodation for the left eye, and poor vergence facility.

10. There was no association determined between the mainstream group and moderate to large head movements with saccadic ($p = 0.549$) and pursuit ($p = 0.127$) eye movements, poor pursuit ability ($p = 0.789$) and base in vergences, although the prevalence was found to be high in this group (mainstream).

11. There was no association between the learning disabled and reduced visual acuities at near for the right and left eyes ($p = 0.439$), reduced visual acuities at near for both eyes ($p = 0.860$), poor accommodation facility ($p = 0.053$), abnormal cover test at near ($p = 0.098$) and poor saccadic ability ($p = 0.742$). These were all observed results of high prevalence in the learning disabled.

12. There was an association between the learning disabled and reduced visual acuities at distance for the right eye ($p = 0.027$); reduced visual acuities at distance of the left eye ($p = 0.003$); reduced visual acuities at distance of both eyes ($p = 0.005$); myopia ($p = 0.006$); compound myopic astigmatism ($p = 0.006$); mixed astigmatism ($p = 0.006$); and poor pursuit accuracy ($p = 0.000$). These results were found to be statistically significant (p-values < 0.05), although the association between the mentioned visual deficiencies and the learning disabled group were found to be weak. Therefore we cannot safely conclude that the relationship exists between the learning disabled and reduced visual acuities at distance for the right, left and both eyes, myopia, compound myopic astigmatism, mixed astigmatism, and poor pursuit accuracy.

13. The high lag of accommodation of the right and left eye ($p = 0.000$); and poor saccadic accuracy ($p = 0.000$) were found to be significantly associated with the learning disabled, and a moderate association was determined using the Cramer' V test. This finding then leads to the conclusion that children labelled as learning disabled are likely to present with a high lag of accommodation and poor saccadic accuracy.

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CHAPTER 6

DISCUSSION

6.1 INTRODUCTION

The focus of this study was on investigating the prevalence of visual deficiencies in children identified as learning disabled, compared to children in mainstream schools who may or may not present with learning disabilities. The visual skills (including the visual acuities, refractive status, accommodation, vergence, ocular motilities and an intact ocular health status) were evaluated in both the learning disabled and the mainstream group. The following discussion will be on our main findings related to visual deficiencies, age, gender, the learning disabled and the mainstream group.

6.2 OVERVIEW ON DEMOGRAPHIC DATA

Two different groups of children were visually evaluated, the learning disabled and a mainstream group where the extent of learning disability was not known. Both groups were not categorized into types of learning disabilities, due to the confidentiality of the information maintained by the sample schools in the study. Therefore the researcher intends referring to the children from the special schools as the learning disabled group, since it is likely that respondents in that school have been placed there as a result of a specific learning disability.

The researcher will now describe some demographic characteristics of the two sample schools as used for purposes of the current study.

I.H. Harris as mentioned in Chapter 2, is one of the mainstream schools including all types of learners (learners with and without learning disabilities). In South Africa the drafting of the White Paper on Education and Training (1996) advocated an inclusive education policy known as outcomes based education, to address the wide diversity of needs in the learner population. The effect of these policies was to address the fact that only approximately 20% of the learners with disabilities are accommodated in special schools whilst the majority who needs educational support are in mainstream schools and are not receiving educational support. I.H.Harris is also one of the many schools in South Africa with the majority of children needing educational support, including proper visual screenings to eliminate obstacles in the process of learning.

The criteria used in South Africa for referring children to the schools of the learning disabled was found to be not very clear. The differences between the two groups was that, the majority of children in the schools of the learning disabled have had their vision evaluated, and have been exposed to other evaluations including the occupational therapists, educational psychologists and speech and hearing therapists(personal communication, 2005). The other differences between the two groups noted were that the schools of the learning disabled had approximately 85% Caucasians and 25% blacks, when the mainstream school consisted of 100% blacks.

Children from I.H.Harris mainstream school are mostly from disadvantaged backgrounds (personal communication, 2006). I.H.Harris is situated in Doornfontein in the city centre where most of the children are from orphanages or single parent families who mostly live in poor conditions. This area may be described as a typically deteriorated urban area in that there is large scale poverty, crime and limited living conditions. According to information provided by the setting it appears that parents are domestic workers or parents earning meagre wages.

The learning disabled respondents are from the School of Achievement in Elsburg, and Lantern Primary school in Roodepoort. Both the schools are situated in the Southern and Western suburbs of Johannesburg. The two schools are public schools specialised to assist learners with average to above average cognitive intelligence who experienced barriers to learning in reading and writing. Both the

School of Achievement and Lantern Primary have educational support systems in house with the Occupational Therapist, Educational Psychologist, Social Worker and Speech and hearing therapist for the academic support of the learners. The two schools of the children with learning problems have less than 20 children in each class, unlike I.H. Harris with more than 30 children in one classroom. The advantage of having fewer learners in a class is that each child gets personal attention from the teachers. It would also be important for the researcher to establish the extent to which the two samples are equal in socio-economic terms. Although no data was collected on socio-economic status it appears from reports by the respective sample schools that there is a great likelihood that these circumstances were not the same for both groups.

Perhaps the greatest limitation of a study of this nature is the fact that the researcher did not have control over the exact demographic composition of the two samples. Though it was planned to select the participating schools purposively the division between learning disability and non-learning disability was not that crisp in the control group. There is a likelihood that children with unidentified learning disabilities did participate in the non-learning disabled sample as previously indicated. It is thus of some importance that the researcher submits evidence indicating that the possible impact of "uncontrolled" learning disability as side-variable is minimal and insignificant.

Based on the above discussion of the general demographic characteristics the researcher will now present statistical evidence to further examine sample equality. From what is presented thus far it should already be clear that there are several environmental factors that may contribute to some of the following problems regarding visual deficiencies of learners.

- There is likelihood that learners from poor socio-economic backgrounds are not familiar with visual testing procedures. This may have impacted on the results of visual evaluations and stresses the importance of selecting evaluation methods that are suitable for children from such backgrounds.

- Due to those same background factors it is likely that such children have not been properly evaluated before, and therefore do not have experience of testing procedures.
- It is possible that due to a lack of visual screenings in schools some learners may in fact present with visual problems that may be associated with learning unidentified learning disabilities.

Before any of the above questions may be answered it is necessary to examine the characteristics of the sample in order to determine if indeed the two samples were different from each other or were likely to be similar to typical school settings.

6.3 CHARACTERISTICS OF THE SAMPLE

6.3.1 GENDER

There is conflicting evidence on the role of gender as a contributing factor for the development of learning disabilities as highlighted in chapter 2. According to a study conducted by Seigel and Smythe (2005), a collection of data from a large unbiased sample showed no significant differences between males and females in the incidence of reading difficulties. If data regarding gender distribution for the two samples are compared it is found that there is a higher prevalence of males in the school of the learning disabled than females and more females in the mainstream school. However, a statistically significant relationship exists between the high percentage of boys in the schools of the learning disabled, and the high percentage of girls in the mainstream school, although the association was found to be weak. Therefore it cannot be concluded with certainty in this study, that gender has influence on children being in the school of the learning disabled. It can thus be concluded that in accordance to literature this study is not gender biased in either way and that the sample can be regarded as representative of a typical school setting.

6.3.2 AGE

The respondents were divided into two age groups of 8-10 and 11-13 year olds. The results indicated a significant relationship to exist between age and visual dificiencies across the two samples. Specifically it was found that older children (11-13-year-olds) in lower grades (Grades 3 -4) were more likely to be found in the school of the learning disabled than in the mainstream school. This finding confirms the fact that children in the school of the learning disabled, who are older could have lagged behind due to poor academic performance.

It can therefore be safely concluded that children from the mainstream schools are younger than those from the schools of the learning disabled. It is further concluded on this basis that the mainstream sample is indeed different from the special school sample and that learning disabilities are more likely to be found in the special school setting. This is significant for this study since the researcher did not have access to learning disability information to ensure the two distinctive groups

Based on the above two results it is concluded that the samples used in this study are largely representative of general school settings for mainstream learners and learning disability schools. It is further concluded that both samples are less likely to have similar socio-economic background variables, and that both schools are part of the same educational system. It is possible however that the school for the learning disabled is more likely to perform visual examinations as part of it's screening and evaluation regime, also that learners in this school will be more used to visual screening procedures than learners in the main stream school.

Having established some form of equality in the two samples the researcher will now present some of the most prominent findings regarding visual deficiencies in the two samples.

6.4 VISUAL DEFECIENCIES

6.4.1 VISUAL ACUITY

6.4.1.1 GENDER

Poor distance and near visual acuities of the right, left and both eyes, were found to be more prevalent in the females than in males. However poor distance vision at distance of the right , left and both eyes, including poor near visual acuities of the right and left eye were found not to be statistically significant (p-value>0.05), therefore they are not associated with the female population in the current study. Poor near visual acuities for both eyes were found to statistically associated with the females, although the relationship was found to be of small effect. Therefore we cannot safely conclude that females are likely to present with reduced near visual acuities in both eyes.

6.4.1.2 AGE

The respondents were divided into two groups, the 8-10; and 11-13 -year- olds. In the 8-10-year-olds the prevalence of poor distance visual acuities was found to be high for the right, left and both eyes than in the 11-13-year- old age group. A statistically significant relationship was found to exist between reduced visual acuities and the 8-10-year-old group, however the relationship was found to be of weak strength. Therefore leading to the conclusion that, although a relationship was found to exist between poor distance visual acuities of the left and right eye and the 8-10-year-olds, the strength of the association is small. Therefore we cannot safely conclude that a relationship exists between poor distance visual acuities of the right and left eye and the 8-10-year-old age group. However no relationship was found to exist between the 8-10-year-old age group and poor distance vision in both eyes since the p-value was found to be more than 0.05.

The percentage of poor near visual acuities was found to be high in the right, left and both eyes in the 8-10-year-olds compared to the 11-13-year-old age group. An association between poor near visual acuity of the right, left and both eyes and the 8-10-year-old age group was statistically significant (p-value< 0.05). However even though the association between poor near visual acuities for the right, left and both eyes with 8-10-year-old age group is statistically significant the relationship was found to be of weak strength according to Cramer's V test. Therefore we cannot safely conclude that there is an association between the 8-10-year-old age group and poor near visual acuities of the right, left and both eyes.

The high prevalence of poor visual acuities at both distance and near in the 8-10 year olds can thus be attributed to their immaturity more than poor visual acuity. According to Press, 1993, it is common to find younger children unwilling to read beyond a certain line on the Snellen Chart, in most cases they can read smoothly and fast through to 6/12 then stop.

The above aspect whereby younger children (8-10-year-olds) present with poor visual acuities for both distance and near is of importance in this study. Since children with learning disabilities tend to be older (11-13-years old) as shown in the above results, it is possible that their reading skill for instance is at a different level than those of younger learners. Such difference may have influenced the results as indicated above.

6.4.1.3 LEARNER GROUPS COMPARISONS

A prevalence of respondents with poor distance and near visual acuities of the left, right and both eyes was found in the learning disabled group. An association of small effect was found to exist between poor distance visual acuities of the right, left and both eyes in this group. Although a statistically significant association was found to exist (p-value <0.05) between the learning disabled group and poor visual acuities at distance and near, since it is of small effect we cannot safely conclude that a relationship exists between the variables. The current study partially agrees with the literature review conducted by Grisham and Simons (1986) where the studies of Fendrick (1935) Tillman (1962) were quoted, and evidence was produced supporting the association between poor reading and reduced near acuity in particular binocular acuity.

However clear near vision is a prerequisite for reading printed material. The sample groups are in grades in which they start learning to read, therefore near point acuity can be an index used to identify children with learning problems from those without learning problems.

Visual acuities in most cases can be used to predict refractive status. The relationship between the refractive status and visual acuity was found to be complicated as stated by Rosenbloom and Morgan (1990). Due to the fact that subjects who exhibited uncorrected refractive status of +4.00 with -1.00D cylinder were still able to read 6/9 letters on the Snellen chart. In the next section the researcher will present findings in this area that confirms the complexity as pointed out by the above authors.

6.4.2 REFRACTIVE ERRORS

6.4.2.1 AGE AND GENDER:

The percentage of myopia and compound myopic astigmatism was found to be high in the females than in males. For the left eye the percentage of respondents with hyperopia and mixed astigmatism was found to be the same in both females and males. No relationships were found to exist between the different refractive errors and gender. This therefore leads to the conclusion that the prevalence of refractive errors (for example hyperopia, myopia, compound myopic astigmatism and mixed astigmatism) is the same in females and males. Gender influences on the refractive status have been reported by Morgan (1960), in which no relationship between refractive error and bookishness when the girls were 13 years of age was detected. Thus the results of this study supports that gender is not associated with the refractive status.

Myopia is the most common cause of blurred vision at distance and it has been found by Hirsch (1954) (in Grisham and Simons, 1986) to be less prevalent in the 1st three grades (grade 1, 2, &3) than in the 4th grade and upwards. According to Hirsch (1963) (in Leat, 1999) it is generally found that at birth the spread of refractive error is wider than in the adult population with the mean being more hyperopic. In the current study prevalence of hyperopia was found to be high in the 8-10 than in the 11-13-year-old group.

The current study also reveals a higher prevalence of myopia in the 11-13-year-old group than in the 8-10-year-old group. Blum et al (1959) (in Moore (1997) stated that there is an increase of the prevalence of myopia from 2% at the age of 6-years to 15% by age 15-years. Children in the age group of 8-10-years are thus less likely to present with a high prevalence of myopia compared to children in the older age group (11-13-year-olds). The study of Naidoo et al (2003) revealed that the spherical equivalent refractive error decreased with age from a median of +0.75 in 5-year-olds to +0.50 in 15-year-olds. However in the current study although the association between the refractive errors (myopia, hyperopia, compound myopic astigmatism and mixed astigmatism), and the age were found to be statistically significant, but due to the weak relationship, we cannot safely conclude that younger children (8-10-year-olds) are likely to present with a higher prevalence of hyperopia than older (11-13-year-olds) children.

6.4.2.2 LEARNER GROUPS

In evaluating the refractive status of the right and left eye using the retinoscope, a high percentage of respondents with hyperopia was found in the mainstream than in the learning disabled group. The association between the mainstream group and hyperopia was found to be statistically significant even though the association is weak. This finding is contradictory to Eames's (1955) study in which hyperopia was found to be more prevalent amongst children with the lowest reading level, however in the current study the reading level of the children labeled as learning disabled was not evaluated.

Myopia, compound myopic astigmatism and mixed astigmatism had a high prevalence in the learning disabled. A statistically significant relationship was found to exist between myopia, compound myopic astigmatism, mixed astigmatism and the learning disabled group for the left and right eye even though the association was found to be weak. Therefore since the strengths of the relationships are weak between the variables we cannot with certainty conclude that children form the mainstream schools are likely to present with hyperopia, and those from the schools of the learning disabled with myopia, compound myopic astigmatism and mixed astigmatism.

The above finding should be compared to what is found by different authors. Eames's (1948) study as mentioned in Chapter 2 compared the refractive status of poor readers, eye clinic patients and randomly selected samples of children.

This study showed a higher prevalence of hyperopia in the poor readers, with myopia the same among poor readers and the randomly selected children. A high percentage of respondents with myopia was found in eye clinic patients. Contrary to the findings of the current study Rosner and Rosner (1987) in agreement to Eames (1948), found a higher prevalence of hyperopia in the learning disabled group than in children with no learning disabilities. Rosner and Rosner (1987) also found a high prevalence of myopia in children with no learning disabilities, with astigmatism occurring equally in both the children with learning problems and those with no learning problems. However equal prevalence of refractive errors amongst poor, average and advanced readers were reported in Helveston et al. (1985) and Norn et al's (1969) studies.

Generally uncorrected hyperopia affects accommodation and the vergence system, and it thus plays an important role in the process of reading than in the case of myopia. As indicated the findings of the current study are contradictory whereby the prevalence of hyperopia was found to be more prevalent in the mainstream than in the learning disabled group. Such finding should however be observed with caution since it is likely that learners with learning disabilities are likely to be found in the mainstream school due to factors inherent to the school system. It is possible that children with reading or learning disabilities may be undetected. The small sample size in this study may have contributed to these results. It is noteworthy that the learning capacity and different social and cultural backgrounds of the samples could not have influenced the result since the refractive error status was determined objectively and not subjectively and thus the respondents were not expected to participate in the process of evaluation.

6.4.3 ACCOMMODATION

The three components of accommodation were evaluated, according to Scheiman and Wick (2002) for a complete assessment of the accommodative system. The three components of accommodation evaluated included the amplitude, facility and response (accuracy).

6.4.3.1 ACCOMMODATION ACCURACY

6.4.3.1.1 GENDER AND AGE

Age was found not to be associated with a high lag and lead of accommodation, although respondents with a high lag (>0.75) were found to be more in the 11-13-year-olds and those with the lead of accommodation to be more in the 8-10-year-olds. Therefore this leads to the conclusion that the prevalence of the high lag and lead of accommodation is the same in the 11-13 and the 8-10-year-olds. Rouse, Hutter and Shiftlett (1984) in their collection of data from the general population of school going age children, found a prevalence of 95% of a lag of accommodation lying between +1.00D to a lead of 0.35D. According to their findings the lag of accommodation was found to be increasing slightly with age. The findings of the current study revealed a high prevalence of a high lag of accommodation in the older age group (11-13-year-olds) than in the 8-10-year-old group and supports the Rouse et al (1984) study. However according to the findings of the current study there is no association between accommodation accuracy and the age groups, and thus a conclusion can be reached that the prevalence of poor accommodation accuracy is the same in the 8-10-year-olds and the 11-13-year- olds.

6.4.3.1.2 LEARNER GROUPS

The percentage of respondents with a high lag of accommodation was found to be high in the learning disabled group and with the lead of accommodation high in the mainstream group. The association between the lead of accommodation and the mainstream group and the high lag of accommodation with the learning disabled was found to be statistically significant but of medium effect. Therefore leading to the conclusion that a moderate relationship exists between a high lag and the learning disabled group, as well as between the lead of accommodation and the mainstream group.

According to Scheiman and Wick (2002) a high lag is associated with high esophoria and inadequate negative fusional vergences, and the lead of accommodation is associated with high exophoria and inadequate positive fusional vergences. The findings of the current study are in agreement with the study conducted by Poytner et al (1982). Poytner et al (1982) investigated the accuracy of the accommodative response when reading, and concluded that a high lag of accommodation is associated with poor reading performance. However although there is a similarity between the findings in the current study and Poytner et al (1982)'s study the difference in the present study is that the reading performance of the respondents were not evaluated.

Although there is a significant association between the high lag accommodation and the learning disabled and between the lead of accommodation and the mainstream school, there is a need for further research on these variables. Further research is necessary since more information in terms of the categorization of learning disabilities of both groups was not determined nor that information was not made available to the researcher. It could also have been interesting in this study to compare the vergence system and the refractive status of the subjects with a high lag and lead of accommodation to add further validity to the findings of this study.

This finding therefore opens doors for further research since a significant relationship was found to exist between the high lag and the learning disabled as well as between the lead of accommodation and the mainstream group. This is due to the fact that both the high lag and lead of accommodation have a negative impact on the visual system especially in the process of reading. The presence of other visual disabilities can lead to the exacerbation of complaints such as asthenopia, headaches, and diplopia with reading and thus lead to avoidance of reading.

6.4.3.2 ACCOMMODATION FACILITY

Accommodation facility was evaluated only binocularly with suppression monitored.

6.4.3.2.1 AGE AND GENDER

In the current study the statistical analysis results are not included regarding the association between age, gender and accommodation facility since no differences were noted in terms of prevalence of accommodation for different age groups and genders. Scheiman et al.'s (1988) study indicated that due to unreliable responses from the children below 8 years of age, accommodative facility testing has questionable results. The expected accommodative facility results were determined to be the same (7cpm: sd +/- 2.50cpm) for the 8 – 12-year-olds. The present study therefore supports the findings from Scheiman et al.'s (1988) study that the accommodation facility of children in the 8-12-year-olds is most likely to be the same.

6.4.3.2.2 LEARNER GROUPS

In this study it was found that the prevalence of poor accommodation facility was high in the learning disabled group than in the mainstream group. However, even though the prevalence was high in the learning disabled group, no relationship was found to exist between poor accommodation facility and the learning disabled group. Therefore leading to the conclusion that the prevalence of poor accommodation facility is the same in the learning disabled and the mainstream group. In support of Rosner and Rosner (1980) study which found the same prevalence of poor accommodation facility in children with and without learning disabilities. Contrary to Hoffman's (1980) study which showed a higher prevalence of poor accommodation facility in the learning disabled group than the control group composed of children referred to the clinic primarily for visual care.

Although the findings of the current study supports the findings of the study of Rosner and Rosner (1980), it would be erroneous to support their hypothesis completely since the learning disabled could also be amongst the mainstream group. Therefore further research in this regard in South Africa is needed to differentiate the accommodation facility of the children with and without learning problems. Although a high prevalence of poor accommodation facility was found in the learning disabled group in the present study, poor accommodation facility is associated with poor amplitudes and age.

6.4.3.3 ACCOMMODATION AMPLITUDE

6.4.3.3.1 GENDER AND AGE

Poor amplitudes of accommodation for the right and left eyes were found to be more prevalent in the males compared to the females. No relationship was observed between poor amplitudes of accommodation of the right and left eye and the males. Therefore leading to the conclusion that poor amplitudes are largely the same for both females and males. The relationship between males and poor amplitudes of accommodation can be attributed to chance, due to the fact that the sample size is relatively small. The other reason is that no study so far has compared the prevalence of poor amplitudes of accommodation between the males and females.

Poor amplitudes of accommodation of the right and left eye were found to be more prevalent in the 8-10 than in 11-13-year-olds. The relationship between the poor amplitudes of accommodation for the left eye and the 8-10-year-olds was found not to exist. There was a statistically significant association between the poor amplitudes of accommodation of the right eye and the 8-10-year-old group. However the association between the poor amplitudes of accommodation for the right eye and the 8-10-year-olds was found to be weak. Therefore we cannot safely conclude children in the 8-10-year-old age group are likely to present with poor amplitudes of the right eye. The findings of the current study regarding the association of poor amplitudes of accommodation for the right eye and the 8-10-year-olds is questionable, since it does not make sense for one eye (right eye) and not the left eye to be affected as well.

6.4.3.3.2 LEARNER GROUPS

The prevalence of poor amplitude of accommodation in each eye (right and left) was found to be high in the mainstream than in the learning disabled group. Although a statistically significant relationship was found to exist between poor amplitudes of the right and left eye in the learning disabled group, a weak association was determined for the right eye, with a moderate association for the left eye. This finding therefore leads to the conclusion that children from the mainstream school are likely to present with poor amplitudes of accommodation of the left eye than the learning disabled group. These results are contrary to the findings of Hoffman's (1980) study that children with learning problems have a higher prevalence of poor amplitudes of accommodation than in the children without learning problems.

Theoretically poor amplitudes have a negative impact on the visual system. Poor amplitudes affect the accommodation accuracy, accommodation facility as well as the vergence system. However according to the findings in the current study it does not make sense that poor amplitudes of the left eye and not the right eye have a moderate association with the learning disabled. Poor responses and lack of understanding of the test could have affected the results, since the amplitudes of accommodation were measured subjectively. In this regard further research is thus recommended.

6.4.4 VERGENCE SYSTEM

In this study a complete evaluation of the vergence system including the near and far horizontal phorias (cover test), near negative (prism base out) and positive (prism base in) fusional vergences, vergence facility and near point of convergence as suggested by Jimenez et al.(2004) were conducted. The following can be reported regarding these different aspects.

6.4.4.1 COVER TEST

6.4.4.1.1 LEARNER GROUPS

Eames (1935b, 1948); Good (1938) quoted in Simons and Grisham's (1987) literature review, found a higher prevalence of lower convergence reserves, exophoria and esophoria with lower fusional reserves at near in children with reading disabilities compared to children without reading disability.

The cover test in the current study revealed abnormal findings for distance and near to be higher in the learning disabled than in the mainstream group. The relationship between abnormal cover test findings and the learning disabled respondents was not significant. The findings of the present study on the cover test are in agreement with theories held by Eames (1935b, 1948); Good (1938) quoted in Simons and

Grisham's (1987) literature review, that lower convergence reserves, exophoria and esophoria with lower fusional reserves at near are associated with reading disabilities.

6.4.4.2 NEARPOINT OF CONVERGENCE

The percentage of respondents with the receded nearpoint of convergence was found to be the same in the different age groups, genders and groups. Therefore this leads to the conclusion that reduced nearpoint of convergence is the same irrespective of age, gender and the learning capability (learning disabled and the mainstream) of children. This contradicts the conclusion reached in the literature review of Grisham and Simons (1987) that convergence insufficiency is associated with poor reading performance. The results of this study could confirm however that there may be children with learning disabilities in the mainstream school who participated in the study and that these children may indeed present with high prevalence of convergence insufficiency. Thus the evaluation of the nearpoint of convergence could be included in the visual screenings of all children of school-going age.

6.4.4.3 FUSIONAL VERGENCE RESERVES

A high percentage of respondents in the mainstream group were found to present with poor positive (BO) and negative (BI) fusional reserves. The relationship between the mainstream group and positive fusional reserves was found to be statistically significant (P-value <0.05) but weak. Therefore we cannot safely conclude that children in the mainstream group have poor positive fusional reserves (BO). There was no association determined between the mainstream group and the negative fusional reserves (BI). This is contrary to Marcus's (1974) study that revealed a high prevalence of reduced positive and negative fusional vergences at distance and near in the learning disabled group. Poor responses from the mainstream group could have contributed to the high prevalence of poor fusional vergences in the mainstream group since the test is done subjectively. This finding could indicate that most respondents from the mainstream school were not as able to perform this aspect of visual screening competently compared to respondents from the school of the learning disabled. Lack of reliability in this case may have been due to socio-economic factors as indicated since most of the responses were found to be poor and unreliable.

6.4.4.4 VERGENCE FACILITY

A high percentage of respondents with poor vergence facility were found in the mainstream than in the learning disabled group. A statistically significant association between the mainstream group and poor vergence facility was determined but it was found to be moderate. This finding therefore leads to the conclusion that poor vergence facility is associated with the mainstream group. Buzelli (1986) found significantly slower vergence facility of the reading disabled compared to a control group (with no learning disabilities), which is contrary to the findings of the current study. The evaluation of the vergence facility required the subjective responses of the respondents. Thus poor and unreliable responses have to be taken into consideration in interpreting these findings. The effect of the unknown learning disability factor may be considered as well. Further research on the investigation of vergence facility in the children with and without learning problems is therefore essential.

This finding may indicate another interesting and significant trend. Learners in special schools may be more likely to receive intensive assistance with reading activity and are therefore being stimulated in areas requiring vergence. Although labeled as learning disabled, this group, compared to the mainstream group may be more sophisticated as far as reading activity is concerned. It can be assumed that learners from poor socio-economic backgrounds are less likely to engage or be stimulated in reading activities and are therefore less "sophisticated" than their learning disabled counterparts.

6.4.5 OCULAR MOTILITIES AND LEARNER GROUPS

The pursuit or saccadic eye movements have been described (Cuiffreda et al. 1994 and Griffin et al. 1997) as accurate, rapid eye movements used when reading, requiring a fixation pause each time an object of interest is focused on the retina.

The three types of ocular motilities, pursuits, saccadic and fixation ability have been evaluated in this study. Pursuit and saccadic eye movements have been evaluated based on the head movements, accuracy and ability and the fixation ability was based on the number of fixation losses observed.

6.4.5.1 SACCADIC EYE MOVEMENTS

Although poor saccadic eye movements regarding the moderate to large head movements and ability were found to be more prevalent in the mainstream than in the learning disabled group. No relationship was found to exist between mainstream group and moderate to large head movements. This finding therefore leads to the conclusion that the prevalence of moderate to large head movements is the same in the learning disabled and the mainstream school.

A high percentage of respondents with poor saccadic accuracy and poor saccadic ability were found in the learning disabled than in the mainstream group. An association of moderate strength was found to exist between poor saccadic accuracy and the learning disabled group (p-value<0.05; Cramer's V>0.3). There was no association between poor saccadic ability and the learning disabled determined. This finding therefore leads to the conclusion that the learning disabled children are likely to present with poor saccadic accuracy than children in the mainstream. This supports Chernick's (1978), Hoffman (1980) and Marcus's (1974) studies which indicated a higher prevalence of inefficient ocular motilities in the learning disabled.

Griffin et al (1997) stated that dysfunctional saccadic eye movements can easily disrupt the process of efficient reading. It is thus expected that if there are reading difficulties the poor saccadic accuracy, ability and head/body movements will be encountered. Although in this study the prevalence of poor saccadic accuracy ability was found poor saccadic ability and moderate to large head movements were not associated with learning disabled. Therefore it will be important for the visual screenings of the children in the school of the learning disabled and mainstream to include the assessment of ocular motilities.

6.4.5.2 PURSUIT EYE MOVEMENTS

Poor pursuit accuracy was found to be more prevalent in the learning disabled group than in the mainstream school. An association of weak strength was found to exist between poor pursuit accuracy and the learning disabled group. The high prevalence of poor pursuit eye movements in the learning disabled is in support of the studies done by Hoffman (1980), and Marcus (1974). Although the prevalence of poor pursuit accuracy was found in the learning disabled group, a conclusion cannot be safely reached that the learning disabled have poor pursuit accuracy.

Scheiman and Rouse (1994) stated that conscious effort is required to track an object across a stationary, textured background. Therefore the attentional capability of an individual can be evaluated by observing the smooth-pursuit ability. Disorders of attention according to Brown and Waynne (1984) and Hinshaw (1987) are characteristized by difficulty sustaining attention to a task over time, focusing attention, and completing work, therefore leading to difficulties in reading and learning. However the finding in the present study of a high percentage of respondents with poor pursuit accuracy in the learning disabled raises important epidemiological issues in terms of the visual disabilities associated with the process of reading. Therefore there exists a need for a comprehensive visual screening programme including the evaluation of ocular motilities in all children of school-going age.

6.4.5.3 FIXATION ABILITY

A high percentage of respondents with poor fixation ability was found in the mainstream group than in the learning disabled. A significant but weak relationship was found to exist between poor fixation ability and the mainstream group. Griffin *et al* (1997) stated that steady fixation ability is important in information processing since it allows the object of interest to rest on the fovea. In the presence of unsteady fixation ability the clarity of the object fixated is affected and this can contribute towards deficient saccadic eye movements.

Poytner's, *et al.* (1982) study revealed that collective oculomotor dysfunctions (decreased forward saccades length, increased regressions, increased fixation duration and lag of accommodation) are related to poor reading performance, but not when independently evaluated. The findings of the present study supports Poytner's *et al* (1982) study, that when the individual oculomotor functions are independently evaluated, only marginal significant relations are revealed.

The current study found a high percentage of respondents with poor fixation ability in the mainstream school compared to the learning disabled group and this draws our attention to the importance of a comprehensive visual screening programme including the evaluation of ocular motilities.

6.5 CONCLUSION:

In the current study males are statistically associated with the learning disabled, and females with the mainstream schools. However the association was found to be of weak strength, thus we cannot safely conclude that males are likely to be found in the schools of the learning disabled than females. There was no association between all the visual deficiencies evaluated and gender, thus we can conclude that gender has no effect on the visual deficiencies (poor visual acuities at distance and near, uncorrected refractive errors, accommodation dysfunctions, deficient vergences and poor ocular motilities) investigated.

Age was found not to be associated with reduced visual acuities of the right , left and both eyes as well as with reduced distance visual acuities of both eyes (8-10-year-olds), hyperopia and mixed astigmatism of the left eye (8-10-year-olds), poor pursuit accuracy (8-10-year-olds), poor amplitudes of accommodation of the left eye (8-10-year-olds), myopia and compound myopic astigmatism of the left eye (11-13-year-olds), poor saccadic accuracy (11-13-year-olds) and accommodation accuracy (high lag and lead). Therefore leading to the conclusion that reduced visual acuities for both distance and near of the right, left and both eyes, refractive errors, poor pursuit accuracy, poor saccadic accuracy, poor amplitudes of accommodation of the left eye, and poor accommodation accuracy are the same in both the learning disabled and the mainstream schools.

There was a statistically significant association between the 8-10-year-old age group and reduced distance visual acuities of the right and left eyes, hyperopia and mixed astigmatism, reduced base out vergences including poor fixation ability. Although the association was found to be weak, thus we cannot safely conclude that the 8-10-year-olds have the above mentioned visual deficiencies. In the 11-13-year-olds a statistically significant association was detected for myopia and compound myopic astigmatism of the left eye, even though the relationship was found to be weak, we cannot safely conclude that the 11-13-year-olds have myopia and compound myopic astigmatism of the right eye.

Gender and age were found not to have any effect on the visual deficiencies evaluated. It was shown that the two learner groups (the learning disabled and the mainstream group), were different in terms of the learning disabled group composed of a high percentage and males and the 11-13-year-olds. However although the statistically significant relationships were detected they were found to be weak, therefore it cannot be safely concluded that age and gender are related to the above mentioned visual deficiencies. Age according to Scheiman et al (2002) and Jimenez et al (2004) was found to have no effect on the visual skills including near point of convergence accommodation facility, ocular motilities and ocular health status.

The association between visual deficiencies and the mainstream as well as the learning disabilities presented with some confirmations to literature and some contradictions. The mainstream group was found to be associated with hyperopia, lead of accommodation of the right and left eye, poor amplitudes of accommodation of the right and left eye, and poor vergence facility. A moderate association has been determined between the mainstream group and the lead of accommodation of the right and left eye, poor amplitude of accommodation of the left eye and poor vergence facility. Therefore we can conclude that children from the mainstream school are likely to have the lead of accommodation, poor amplitude of accommodation of the left eye and poor vergence facility. Even though an association was found between poor amplitude of accommodation of the left eye, and poor fixation ability the relationship was found to be weak.

The learning disabled group was found to have a moderate association with a high lag of accommodation of the right and left eye and saccadic accuracy. Therefore a conclusion can be reached that children with learning disabilities are likely to have a high lag of accommodation and poor saccadic accuracy. For the other visual deficiencies including poor visual acuities at both distance and near of the right, left and both eyes, myopia, compound myopic astigmatism, mixed astigmatism and poor pursuit accuracy a weak relationship was determined. Therefore we cannot safely conclude that the children with learning disabilities have poor distance and near visual acuities of the right, left and both eyes, myopia, compound myopic astigmatism, mixed astigmatism and poor pursuit accuracy.

Both learner groups are associated with different visual deficiencies. Although the prevalence of visual deficiencies and their relationships between the two learner groups were found to be different, it is not clear as to which group presents with more visual deficiencies than the other. Therefore this leads to the conclusion that the prevalence of visual deficiencies is the same in the learning disabled and the mainstream group.

Through this analysis the researcher has come to a few significant conclusions regarding the nature and realities of visual screenings and visual evaluations in South African schools. These conclusions will be presented in the next chapter. At a secondary level the researcher has come to noteworthy conclusions regarding learning disabilities in South African schools as well as the influence of socio-economic conditions on learning problem identification as well as visual problem identification.

Specifically the following is presented:

- The researcher is acutely aware that certain visual screening procedures and test procedures are difficult to implement. Especially procedures involving a measure of subjectivity, and participation from the subject should be conducted with caution as these might seriously impact on the validity of results.

- It was clear from this study that the respondent's socio-economic background and associated developmental lags and lack of exposure may have contributed to poor performance in some of the screening procedures. Also that learning disabled children were more likely to have been screened before and are therefore familiar with the testing procedures.

- The study has indicated a possible shortfall in visual screenings as implemented in the school system. It appears as if very little screenings are performed in the school system if the participation problems of disadvantaged children is considered.

- A limitation of the study in respect of lack of control over the possible inclusion of unidentified learning disabilities in the mainstream school actually turns out to be a secondary advantage. This study has clearly indicated that for some of the screening procedures it is likely that children with unidentified learning disabilities may exist in the mainstream school. Although this conclusion may in light of the large amount of contradiction regarding such predictions as indicated in the literature study be totally rejected it is possible to assume that there are quite a number of such unidentified learners in the sample mainstream school. One can but only assume that a combination of socio-economic background variables, school system as well as lack of visual assessments in schools contribute to this situation.

The next chapter presents the main conclusions and recommendations.

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CHAPTER 7

RECOMMENDATIONS AND CONCLUSIONS

7.1 INTRODUCTION

As was indicated in Chapter 1 there is significant contradiction regarding the association between visual problems and learning disability. Although several studies indicate such relationship to exist several other studies found no relationship to exist. These contradictions have partly motivated the researcher to conduct this research. Another reason for conducting this research is the observation that clinical data concerning visual deficiencies in children with learning disabilities in South Africa is scarce or not available. Specifically clinical data regarding the prevalence of visual disabilities in school children appears not to be available.

The goal for this research was thus formulated around investigating the prevalence of visual deficiencies in the learning disabled compared to children in mainstream schools.

In this study a battery of visual tests (including visual acuities, refractive status, accommodation, vergence system and the ocular motilities, according to Scheiman & Wick, 2002 and Garzia, in Scheiman & Rouse, 1994) were used to evaluate the visual condition of each research subject. This chapter presents conclusions and recommendation that were reached from this study.

7.2 RECOMMENDATIONS

Specific trends were observed as indicated above. Certain visual deficiencies were specifically associated with the learners in the schools for learning disabled whilst contrary to what was expected, other visual deficiencies were specifically observed in the mainstream school. Based on the above findings and taking into account that the above trends were influenced by variables inherent to the school system the following recommendations can be made:

- This study did not provide concrete answers regarding the debate surrounding the association between visual deficiencies and learning disabilities. The study indicated that certain visual deficiencies appear to be associated with the learning disabled children, but then it was also found that certain visual deficiencies were associated with the mainstream school. It would be recommended that further research be conducted on larger samples to test the hypotheses that were generated by this study. Such research would shed light on the likelihood of an association between visual deficiencies and learning disabilities.

- As explained in the previous Chapter 2, the control group (the learning disabled) came from a mainstream school, which according to the definition from the White Paper 6 (1996) includes all types of learners (the learning disbled and the not learning disabled).

- It is thus likely that learning disabled children may be found in mainstream schools and that such learning problems often go undetected. Furthermore it is likely that the presence of visual deficiencies and their effect on learning often go undetected. It is thus recommended that visual screenings are more actively incorporated in the assessment of learning disabilities, or scheduled visual examinations performed at schools may indeed assist with the early identification of learning disabilities.

- Since the lack of information on specific categorization of learning disabilities may be perceived as a limitation in this study it is recommended that further research on the association between visual deficiencies and different types of learning disabilities should include data about learning disabilities to improve the rigour of such research.

- Since the experimental group (learning disabled) and the control group (mainstream) came from different social and cultural backgrounds this may have influenced the accuracy of the different visual evaluations. The group with learning problems was composed of 75% to 80% Caucasians and the mainstream group was composed of 100% Africans. The effect of the cultural and social differences on learning and visual disabilities is therefore recommended for further research.

- Another area, in which research is recommended, is the investigation of the battery of tests or the screening technique that would be effective in the detection of visual deficiencies in the children of school going age, irrespective of their learning capabilities. Such research may improve the accuracy (validity) and reliability of visual evaluation techniques.

7.3 CONCLUSIONS

In conclusion, the two learner groups (the learning disabled and the mainstream) in the current study were found to have high prevalence of different visual deficiencies. In the current study statistically significant associations of the children in the mainstream school and lead of accommodation of the right and left eye, poor amplitudes of accommodation of the right and left eye, reduced base out vergences, poor vergence facility, and poor fixation ability were found to exist. Of the named visual deficiencies the lead of accommodation of the right and left eye poor amplitude of accommodation of the left eye and poor accommodation facility were found to have a moderate association, therefore leading to the conclusion that children from the mainstream school are likely to present with a lead of accommodation in the right and left eye, poor amplitude of accommodation of the left eye and poor vergence facility.

The learning disabled children in this study were found to have a statistically significant association with poor visual acuities for distance and near in the right, left and both eyes, myopia, compound myopic astigmatism and mixed astigmatism, high lag of accommodation, poor accommodation facility, abnormal cover test, poor pursuit accuracy including poor saccadic accuracy. A moderate association was found between the learning disabled and a high lag of accommodation of the left and right eye and saccadic accuracy. Therefore a conclusion can be reached that the learning disabled children are likely to present with poor saccadic accuracy and a high lag of accommodation of the right and left eye.

Comparisons of the two groups regarding which group presents with a high prevalence of visual deficiencies is complicated, since both groups present with different visual deficiencies. To conclude that children from the mainstream school or from the school of the learning disabled presented with a high prevalence of visual deficiencies will be erroneous in this study. However it is interesting to note that both groups have visual deficiencies which can impact negatively to their learning skills. Other factors in this study for example social and cultural backgrounds, poor responses from lack of understanding of the tests, or learning problems that were not evaluated prior to the visual evaluations could have also contributed to the outcomes of our findings.

Based on the findings of the current study it is therefore important for the full and proper visual screenings to be conducted at schools, irrespective of whether the school is a mainstream or the school of the learning disabled.

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APPENDICES

APPENDIX A

Table A1:

The relationship between gender and age

Crosstab

			(R)Age				Total
			8 - 9	10	11	12 - 13	
Sex	Male	Count	20	51	23	15	109
		% within Sex	18.3%	46.8%	21.1%	13.8%	100.0%
	Female	Count	19	34	16	13	82
		% within Sex	23.2%	41.5%	19.5%	15.9%	100.0%
Total		Count	39	85	39	28	191
		% within Sex	20.4%	44.5%	20.4%	14.7%	100.0%

Table A2:

The relationship between gender and age: Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.029(a)	3	.794
Likelihood Ratio	1.025	3	.795
Linear-by-Linear Association	.025	1	.873
N of Valid Cases	191		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 12.02.

Table A3:

The relationship between visual acuities (RE) @ 6m and age

Crosstab

			(R)Visual acuities 6m: RE		Total
			Normal	Below Normal	
(R)Age	8 - 10	Count	99	26	125
		% within (R)Age	79.2%	20.8%	100.0%
	11 - 13	Count	62	5	67
		% within (R)Age	92.5%	7.5%	100.0%
Total		Count	161	31	192
		% within (R)Age	83.9%	16.1%	100.0%

Table A4:

The relationship between visual acuities (RE) @ 6m and age:

Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	5.731(b)	1	.017		
Continuity Correction(a)	4.788	1	.029		
Likelihood Ratio	6.365	1	.012		
Fisher's Exact Test				.022	.012
Linear-by-Linear Association	5.701	1	.017		
N of Valid Cases	192				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 10.82.

Table A5:

The relationship between visual acuities (RE) @ 6m and age: Cramer's V

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.173	.017
	Cramer's V	.173	.017
N of Valid Cases		192	
a Not assuming the null hypothesis.			
b Using the asymptotic standard error assuming the null hypothesis.			

Table A6:

The relationship between visual acuities of the left eye @6m and age

Crosstab

			(R)Visual acuities 6m: LE		Total
			Normal	Below Normal	
(R)Age	8 - 10	Count	103	22	125
		% within (R)Age	82.4%	17.6%	100.0%
	11 - 13	Count	63	4	67
		% within (R)Age	94.0%	6.0%	100.0%
Total		Count	166	26	192
		% within (R)Age	86.5%	13.5%	100.0%

Table A7:

The relationship between visual acuities of the left eye @6m and age: Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	5.039(b)	1	.025		
Continuity Correction(a)	4.095	1	.043		
Likelihood Ratio	5.655	1	.017		
Fisher's Exact Test				.027	.018
Linear-by-Linear Association	5.013	1	.025		
N of Valid Cases	192				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 9.07.

Table A8:

The relationship between visual acuities of the left eye @6m and age: Cramer's V

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.162	.025
	Cramer's V	.162	.025
N of Valid Cases		192	

a Not assuming the null hypothesis.

b Using the asymptotic standard error assuming the null hypothesis.

Table A9:

The relationship between visual acuities (BE) @ 6m and age

Crosstab

			(R)Visual acuities 6m: BE		Total
			Normal	Below Normal	
(R)Age	8 - 10	Count	107	18	125
		% within (R)Age	85.6%	14.4%	100.0%
	11 - 13	Count	63	4	67
		% within (R)Age	94.0%	6.0%	100.0%
Total		Count	170	22	192
		% within (R)Age	88.5%	11.5%	100.0%

Table A10:

The relationship between visual acuities (BE) @ 6m and age:

Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3.055(b)	1	.080		
Continuity Correction(a)	2.281	1	.131		
Likelihood Ratio	3.358	1	.067		
Fisher's Exact Test				.098	.061
Linear-by-Linear Association	3.039	1	.081		
N of Valid Cases	192				
a Computed only for a 2x2 table					
b 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.68.					

Table A11:

The relationship between visual acuities (RE & LE) @ 40cm and age

Crosstab

			(R)Visual acuities 40m: RE		Total
			Normal	Below Normal	
(R)Age	8 - 10	Count	81	13	94
		% within (R)Age	86.2%	13.8%	100.0%
	11 - 13	Count	63	4	67
		% within (R)Age	94.0%	6.0%	100.0%
Total		Count	144	17	161
		% within (R)Age	89.4%	10.6%	100.0%

Table A12:

The relationship between visual acuities (RE & LE) @ 40cm and age: Chi-Square Test

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.559(b)	1	.110		
Continuity Correction(a)	1.794	1	.180		
Likelihood Ratio	2.723	1	.099		
Fisher's Exact Test				.126	.088
Linear-by-Linear Association	2.543	1	.111		
N of Valid Cases	161				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.07.

Table A13:

The relationship between visual acuities (BE) @ 40cm and different age groups

Crosstab

			(R)Visual acuities 40m: BE		Total
			Normal	Below Normal	
(R)Age	8 - 10	Count	84	10	94
		% within (R)Age	89.4%	10.6%	100.0%
	11 - 13	Count	65	2	67
		% within (R)Age	97.0%	3.0%	100.0%
Total		Count	149	12	161
		% within (R)Age	92.5%	7.5%	100.0%

Table A14:

The relationship between visual acuities (BE) @ 40cm and different age groups: Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3.322(b)	1	.068		
Continuity Correction(a)	2.305	1	.129		
Likelihood Ratio	3.702	1	.054		
Fisher's Exact Test				.125	.060
Linear-by-Linear Association	3.301	1	.069		
N of Valid Cases	161				

a Computed only for a 2x2 table

b 1 cells (25.0%) have expected count less than 5. The minimum expected count is 4.99.

Table A15:

The relationship between visual acuities (RE) @ 6m and gender

Crosstab

			(R)Visual acuities 6m: RE		Total
			Normal	Below Normal	
Sex	Male	Count	95	14	109
		% within Sex	87.2%	12.8%	100.0%
	Female	Count	65	17	82
		% within Sex	79.3%	20.7%	100.0%
Total		Count	160	31	191
		% within Sex	83.8%	16.2%	100.0%

Table A16:

The relationship between visual acuities (RE) @ 6m and gender:

Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.141(b)	1	.143		
Continuity Correction(a)	1.601	1	.206		
Likelihood Ratio	2.120	1	.145		
Fisher's Exact Test				.167	.103
Linear-by-Linear Association	2.130	1	.144		
N of Valid Cases	191				
a Computed only for a 2x2 table					
b 0 cells (.0%) have expected count less than 5. The minimum expected count is 13.31.					

Table A17:

The relationship between visual acuities (LE) @ 6m and gender

Crosstab

			(R)Visual acuities 6m: LE		Total
			Normal	Below Normal	
Sex	Male	Count	98	11	109
		% within Sex	89.9%	10.1%	100.0%
	Female	Count	67	15	82
		% within Sex	81.7%	18.3%	100.0%
Total		Count	165	26	191
		% within Sex	86.4%	13.6%	100.0%

Table A18:

The relationship between visual acuities (LE) @ 6m and gender:

Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.676(b)	1	.102		
Continuity Correction(a)	2.024	1	.155		
Likelihood Ratio	2.647	1	.104		
Fisher's Exact Test				.135	.078
Linear-by-Linear Association	2.662	1	.103		
N of Valid Cases	191				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 11.16.

Table 19:

The relationship between visual acuities (BE) @ 6m and gender:

Crosstab

			(R)Visual acuities 6m: BE		Total
			Normal	Below Normal	
Sex	Male	Count	101	8	109
		% within Sex	92.7%	7.3%	100.0%
	Female	Count	68	14	82
		% within Sex	82.9%	17.1%	100.0%
Total		Count	169	22	191
		% within Sex	88.5%	11.5%	100.0%

Table 20:

The relationship between visual acuities (BE) @ 6m and gender:

Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.350(b)	1	.037		
Continuity Correction(a)	3.448	1	.063		
Likelihood Ratio	4.313	1	.038		
Fisher's Exact Test				.042	.032
Linear-by-Linear Association	4.328	1	.038		
N of Valid Cases	191				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 9.45.

Table 21:

The relationship between visual acuities (BE) @ 6m and gender: Cramer's V

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.151	.037
	Cramer's V	.151	.037
N of Valid Cases		191	

a Not assuming the null hypothesis.

b Using the asymptotic standard error assuming the null hypothesis.

Table 22:

The relationship between visual acuities (RE & LE) @ 40cm and gender

Crosstab

			(R)Visual acuities 40m: RE		Total
			Normal	Below Normal	
Sex	Male	Count	84	6	90
		% within Sex	93.3%	6.7%	100.0%
	Female	Count	59	11	70
		% within Sex	84.3%	15.7%	100.0%
Total		Count	143	17	160
		% within Sex	89.4%	10.6%	100.0%

Table 23:

The relationship between visual acuities (RE) @ 40cm and gender:

Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3.394(b)	1	.065		
Continuity Correction(a)	2.508	1	.113		
Likelihood Ratio	3.379	1	.066		
Fisher's Exact Test				.075	.057
Linear-by-Linear Association	3.373	1	.066		
N of Valid Cases	160				
a Computed only for a 2x2 table					
b 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.44.					

Table 24:

The relationship between visual acuities (BE) @ 40cm and gender

Crosstab

			(R)Visual acuities 40m: BE		Total
			Normal	Below Normal	
Sex	Male	Count	84	6	90
		% within Sex	93.3%	6.7%	100.0%
	Female	Count	64	6	70
		% within Sex	91.4%	8.6%	100.0%
Total		Count	148	12	160
		% within Sex	92.5%	7.5%	100.0%

Table 25:

The relationship between visual acuities (BE) @ 40cm and gender:

Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.206(b)	1	.650		
Continuity Correction(a)	.023	1	.880		
Likelihood Ratio	.204	1	.651		
Fisher's Exact Test				.765	.436
Linear-by-Linear Association	.205	1	.651		
N of Valid Cases	160				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.25.

APPENDIX B

Table B1:

The relationship between refractive Error (RE) and gender

Crosstab

			Refractive Error: RE				Total
			Myopia	Hyperopia	Compound Myopic Astigmatism	Mixed Astigmatism	
Sex	Male	Count	8	52	12	36	108
		% within Sex	7.4%	48.1%	11.1%	33.3%	100.0%
	Female	Count	7	38	10	27	82
		% within Sex	8.5%	46.3%	12.2%	32.9%	100.0%
Total		Count	15	90	22	63	190
		% within Sex	7.9%	47.4%	11.6%	33.2%	100.0%

Table B2:

The relationship between refractive Error (RE) and gender: Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.157(a)	3	.984
Likelihood Ratio	.156	3	.984
Linear-by-Linear Association	.003	1	.954
N of Valid Cases	190		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.47.

Table B3:

The relationship between refractive error (LE) and gender

Crosstab

			Refractive Error: LE				Total
			Myopia	Hyperopia	Compound Myopic Astigmatism	Mixed Astigmatism	
Sex	Male	Count	4	47	13	44	108
		% within Sex	3.7%	43.5%	12.0%	40.7%	100.0%
	Female	Count	5	35	8	33	81
		% within Sex	6.2%	43.2%	9.9%	40.7%	100.0%
Total		Count	9	82	21	77	189
		% within Sex	4.8%	43.4%	11.1%	40.7%	100.0%

Table B4:

The relationship between refractive error (LE) and gender: Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.788(a)	3	.852
Likelihood Ratio	.782	3	.854
Linear-by-Linear Association	.097	1	.755
N of Valid Cases	189		

a 1 cells (12.5%) have expected count less than 5. The minimum expected count is 3.86.

Table B5:

The relationship between refractive error (RE) and age

Crosstab

			Refractive Error: RE				Total
			Myopia	Hyperopia	Compound Myopic Astigmatism	Mixed Astigmatism	
(R)Age	8 – 10	Count	7	60	9	48	124
		% within (R)Age	5.6%	48.4%	7.3%	38.7%	100.0%
	11 – 13	Count	8	30	13	16	67
		% within (R)Age	11.9%	44.8%	19.4%	23.9%	100.0%
Total		Count	15	90	22	64	191
		% within (R)Age	7.9%	47.1%	11.5%	33.5%	100.0%

Table B6:

The relationship between refractive error (RE) and age: Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.740(a)	3	.013
Likelihood Ratio	10.464	3	.015
Linear-by-Linear Association	2.371	1	.124
N of Valid Cases	191		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.26.

Table B7:

The relationship between refractive error (RE) and age: Cramer's V

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.237	.013
	Cramer's V	.237	.013
N of Valid Cases		191	

a Not assuming the null hypothesis.

b Using the asymptotic standard error assuming the null hypothesis.

Table B8:

The relationship between refractive error (LE) and age

Crosstab

			Refractive Error: LE				Total
			Myopia	Hyperopia	Compound Myopic Astigmatism	Mixed Astigmatism	
(R)Age	8 – 10	Count	4	54	13	53	124
		% within (R)Age	3.2%	43.5%	10.5%	42.7%	100.0%
	11 – 13	Count	5	28	8	25	66
		% within (R)Age	7.6%	42.4%	12.1%	37.9%	100.0%
Total		Count	9	82	21	78	190
		% within (R)Age	4.7%	43.2%	11.1%	41.1%	100.0%

Table B9:

The relationship between refractive error (LE) and age: Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.086(a)	3	.555
Likelihood Ratio	1.989	3	.575
Linear-by-Linear Association	.651	1	.420
N of Valid Cases	190		

a 1 cells (12.5%) have expected count less than 5. The minimum expected count is 3.13.

APPENDIX C

ACCOMMODATION

ACCOMMODATION ACCURACY

Table C1:

The relationship between accommodation accuracy (RE) and age

Crosstab

			(RR)Accommodation: Response: RE			Total
			Normal Lag	High Lag	Lead of Accommodation	
(R)Age	8 - 9	Count	31	1	7	39
		% within (R)Age	79.5%	2.6%	17.9%	100.0%
	10	Count	56	4	23	83
		% within (R)Age	67.5%	4.8%	27.7%	100.0%
	11	Count	25	4	10	39
		% within (R)Age	64.1%	10.3%	25.6%	100.0%
	12 - 13	Count	22	3	3	28
		% within (R)Age	78.6%	10.7%	10.7%	100.0%
Total		Count	134	12	43	189
		% within (R)Age	70.9%	6.3%	22.8%	100.0%

Table C2:

The relationship between accommodation accuracy (RE) and age:

Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.213(a)	6	.302
Likelihood Ratio	7.599	6	.269
Linear-by-Linear Association	.034	1	.854
N of Valid Cases	189		

a 3 cells (25.0%) have expected count less than 5. The minimum expected count is 1.78.

Table C3:

The relationship between accommodation accuracy (LE) and age

Crosstab

			(RR)Accommodation: Response: LE			Total
			Normal Lag	High Lag	Lead of Accommodation	
(R)Age	8 - 9	Count	32	1	6	39
		% within (R)Age	82.1%	2.6%	15.4%	100.0%
	10	Count	53	7	23	83
		% within (R)Age	63.9%	8.4%	27.7%	100.0%
	11	Count	25	3	10	38
		% within (R)Age	65.8%	7.9%	26.3%	100.0%
	12 - 13	Count	21	3	4	28
		% within (R)Age	75.0%	10.7%	14.3%	100.0%
Total		Count	131	14	43	188
		% within (R)Age	69.7%	7.4%	22.9%	100.0%

Table C4:

The relationship between accommodation accuracy (LE) and age: Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.131(a)	6	.409
Likelihood Ratio	6.672	6	.352
Linear-by-Linear Association	.061	1	.804
N of Valid Cases	188		

a 3 cells (25.0%) have expected count less than 5. The minimum expected count is 2.09.

Table C5:

The relationship between accommodation accuracy (RE) and gender

Crosstab

			(RR)Accommodation: Response: RE			Total
			Normal Lag	High Lag	Lead of Accommodation	
Sex	Male	Count	77	7	23	107
		% within Sex	72.0%	6.5%	21.5%	100.0%
	Female	Count	57	5	19	81
		% within Sex	70.4%	6.2%	23.5%	100.0%
Total		Count	134	12	42	188
		% within Sex	71.3%	6.4%	22.3%	100.0%

Table C6:

The relationship between accommodation accuracy (RE) and gender: Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.106(a)	2	.949
Likelihood Ratio	.105	2	.949
Linear-by-Linear Association	.083	1	.773
N of Valid Cases	188		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.17.

Table C7:

The relationship between accommodation accuracy (LE) and gender

Crosstab

			(RR)Accommodation: Response: LE			Total
			Normal Lag	High Lag	Lead of Accommodation	
Sex	Male	Count	76	8	23	107
		% within Sex	71.0%	7.5%	21.5%	100.0%
	Female	Count	55	6	19	80
		% within Sex	68.8%	7.5%	23.8%	100.0%
Total		Count	131	14	42	187
		% within Sex	70.1%	7.5%	22.5%	100.0%

Table C8:

The relationship between accommodation accuracy (LE) and gender: Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.138(a)	2	.934
Likelihood Ratio	.137	2	.934
Linear-by-Linear Association	.134	1	.714
N of Valid Cases	187		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.99.

ACCOMMODATION AMPLITUDE

Table C9:

The relationship between accommodation amplitude (RE) and age

Crosstab

			(R)Accommodation: Amplitude: RE				Total
			Above Average	Average	Slightly Below Average	Below/Extremely Below / Ill-Sustained	
(R)Age	8 – 10	Count	49	16	21	18	104
		% within (R)Age	47.1%	15.4%	20.2%	17.3%	100.0%
	11 – 13	Count	32	6	21	2	61
		% within (R)Age	52.5%	9.8%	34.4%	3.3%	100.0%
Total		Count	81	22	42	20	165
		% within (R)Age	49.1%	13.3%	25.5%	12.1%	100.0%

Table C10:

The relationship between accommodation amplitude (RE) and age: Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.415(a)	3	.015
Likelihood Ratio	11.697	3	.008
Linear-by-Linear Association	1.141	1	.285
N of Valid Cases	165		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.39.

Table C11:

The relationship between accommodation amplitude (RE) and age: Cramer's V

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.251	.015
	Cramer's V	.251	.015
N of Valid Cases		165	
a Not assuming the null hypothesis.			
b Using the asymptotic standard error assuming the null hypothesis.			

Table C12:

The relationship between accommodation amplitude (LE) and age

Crosstab

			(R)Accommodation: Amplitude: LE				Total
			Above Average	Average	Below Average	Below/Extremely Below/ Ill-Sustained	
(R)Age	8 – 10	Count	51	13	23	15	102
		% within (R)Age	50.0%	12.7%	22.5%	14.7%	100.0%
	11 – 13	Count	31	7	22	2	62
		% within (R)Age	50.0%	11.3%	35.5%	3.2%	100.0%
Total		Count	82	20	45	17	164
		% within (R)Age	50.0%	12.2%	27.4%	10.4%	100.0%

Table C13:

The relationship between accommodation amplitude (LE) and age: Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.321(a)	3	.062
Likelihood Ratio	8.174	3	.043
Linear-by-Linear Association	.324	1	.569
N of Valid Cases	164		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.43.

Table C14:

The relationship between accommodation amplitude (RE) and gender

Crosstab

			(R)Accommodation: Amplitude: RE				Total
			Above Average	Average	Slightly Below Average	Below/Extremely Below / Ill-Sustained	
Sex	Male	Count	45	12	24	15	96
		% within Sex	46.9%	12.5%	25.0%	15.6%	100.0%
	Female	Count	35	10	18	5	68
		% within Sex	51.5%	14.7%	26.5%	7.4%	100.0%
Total		Count	80	22	42	20	164
		% within Sex	48.8%	13.4%	25.6%	12.2%	100.0%

Table C15:

The relationship between accommodation amplitude (RE) and gender: Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.584(a)	3	.460
Likelihood Ratio	2.724	3	.436
Linear-by-Linear Association	1.243	1	.265
N of Valid Cases	164		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.29.

Table C16:

The relationship between accommodation amplitude (LE) and gender

Crosstab

			(R)Accommodation: Amplitude: LE				Total
			Above Average	Average	Slightly Below Average	Below/Extremely Below / Ill-Sustained	
Sex	Male	Count	42	13	27	14	96
		% within Sex	43.8%	13.5%	28.1%	14.6%	100.0%
	Female	Count	39	7	18	3	67
		% within Sex	58.2%	10.4%	26.9%	4.5%	100.0%
Total		Count	81	20	45	17	163
		% within Sex	49.7%	12.3%	27.6%	10.4%	100.0%

Table C17:

The relationship between accommodation amplitude (LE) and gender: Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.855(a)	3	.119
Likelihood Ratio	6.287	3	.098
Linear-by-Linear Association	4.254	1	.039
N of Valid Cases	163		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.99.

APPENDIX D

VERGENCE SYSTEM

Table D1:

The relationship between NPC (Break) and groups

Crosstab

			NPC: Break		Total
			Normal	Abnormal	
Group	Learning disabled	Count	81	27	108
		% within Group	75.0%	25.0%	100.0%
	Main	Count	60	20	80
		% within Group	75.0%	25.0%	100.0%
Total		Count	141	47	188
		% within Group	75.0%	25.0%	100.0%

Table D2:

The relationship between NPC (Break) and groups: Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.000(b)	1	1.000		
Continuity Correction(a)	.000	1	1.000		
Likelihood Ratio	.000	1	1.000		
Fisher's Exact Test				1.000	.569
Linear-by-Linear Association	.000	1	1.000		
N of Valid Cases	188				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 20.00.

Table D3:

The relationship between NPC (recovery) and groups

Crosstab

			NPC: Recovery		Total
			Normal	Abnormal	
Group	Learning disabled	Count	81	27	108
		% within Group	75.0%	25.0%	100.0%
	Main	Count	60	20	80
		% within Group	75.0%	25.0%	100.0%
Total		Count	141	47	188
		% within Group	75.0%	25.0%	100.0%

Table D4:

The relationship between NPC (recovery) and groups:

Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.000(b)	1	1.000		
Continuity Correction(a)	.000	1	1.000		
Likelihood Ratio	.000	1	1.000		
Fisher's Exact Test				1.000	.569
Linear-by-Linear Association	.000	1	1.000		
N of Valid Cases	188				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 20.00.

Table D5:

The relationship between step vergences (BI) and groups

Crosstab

			Step Vergences: BI		Total
			Normal	Poor	
Group	Learning disabled	Count	73	9	82
		% within Group	89.0%	11.0%	100.0%
	Main	Count	62	17	79
		% within Group	78.5%	21.5%	100.0%
Total		Count	135	26	161
		% within Group	83.9%	16.1%	100.0%

Table D6:

The relationship between step vergences (BI) and groups:

Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3.303(b)	1	.069		
Continuity Correction(a)	2.570	1	.109		
Likelihood Ratio	3.343	1	.067		
Fisher's Exact Test				.087	.054
Linear-by-Linear Association	3.283	1	.070		
N of Valid Cases	161				
a Computed only for a 2x2 table					
b 0 cells (.0%) have expected count less than 5. The minimum expected count is 12.76.					

Table D7:

The relationship between step vergences (BO) and age

Crosstab

			Step Vergences: BO		Total
			Normal	Poor	
(R)Age	8 - 10	Count	55	45	100
		% within (R)Age	55.0%	45.0%	100.0%
	11 - 13	Count	49	11	60
		% within (R)Age	81.7%	18.3%	100.0%
Total		Count	104	56	160
		% within (R)Age	65.0%	35.0%	100.0%

Table D8:

The relationship between step vergences (BO) and age:

Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	11.722(b)	1	.001		
Continuity Correction(a)	10.579	1	.001		
Likelihood Ratio	12.386	1	.000		
Fisher's Exact Test				.001	.000
Linear-by-Linear Association	11.648	1	.001		
N of Valid Cases	160				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 21.00.

Table D9:

The relationship between step vergences (BO) and age:

Cramer's V

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	**Phi**	-.271	.001
	Cramer's V	.271	.001
N of Valid Cases		160	

a Not assuming the null hypothesis.

b Using the asymptotic standard error assuming the null hypothesis.

Table D10:

The relationship between step vergences (BO) and gender

Crosstab

			Step Vergences: BO		**Total**
			Normal	**Poor**	
Sex	**Male**	**Count**	56	29	85
		% within Sex	65.9%	34.1%	100.0%
	Female	**Count**	48	26	74
		% within Sex	64.9%	35.1%	100.0%
Total		**Count**	104	55	159
		% within Sex	65.4%	34.6%	100.0%

Table D11:

The relationship between step vergences (BO) and gender:

Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.018(b)	1	.893		
Continuity Correction(a)	.000	1	1.000		
Likelihood Ratio	.018	1	.893		
Fisher's Exact Test				1.000	.513
Linear-by-Linear Association	.018	1	.893		
N of Valid Cases	159				

a Computed only for a 2x2 table

b 0 cells (.0%) have expected count less than 5. The minimum expected count is 25.60.

Table D12:

The relationship between vergence facility and gender

Crosstab

			Vergence Facility			Total
			Above Average	Normal	Poor	
Sex	**Male**	**Count**	44	39	17	100
		% within Sex	44.0%	39.0%	17.0%	100.0%
	Female	**Count**	21	38	17	76
		% within Sex	27.6%	50.0%	22.4%	100.0%
Total		**Count**	65	77	34	176
		% within Sex	36.9%	43.8%	19.3%	100.0%

Table D13:

The relationship between vergence facility and gender:

Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.971(a)	2	.083
Likelihood Ratio	5.047	2	.080
Linear-by-Linear Association	3.817	1	.051
N of Valid Cases	176		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 14.68.

Table D14:

The relationship between vergence facility and age

Crosstab

			Vergence Facility			Total
			Above Average	Normal	Poor	
(R)Age	8 - 10	Count	44	54	20	118
		% within (R)Age	37.3%	45.8%	16.9%	100.0%
	11 - 13	Count	21	24	14	59
		% within (R)Age	35.6%	40.7%	23.7%	100.0%
Total		Count	65	78	34	177
		% within (R)Age	36.7%	44.1%	19.2%	100.0%

Table D15:

The relationship between vergence facility and age:

Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.203(a)	2	.548
Likelihood Ratio	1.175	2	.556
Linear-by-Linear Association	.531	1	.466
N of Valid Cases	177		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 11.33.

APPENDIX E

OCULAR MOTILITIES

Table E1:

Cumulative frequency distribution of saccadic eye movements

		3 - 5	4	5	Total
(R)Saccadic: Head	Count	26	74	91	191
	%	13.6%	38.7%	47.6%	100.0%
(R)Saccadic: Accuracy	Count	21	65	105	191
	%	11.0%	34.0%	55.0%	100.0%
(R)Saccadic: Ability	Count	23	60	108	191
	%	12.0%	31.4%	56.5%	100.0%

Table E2:

The relationship between saccadic (accuracy) and gender

Crosstab

			(R)Saccadic: Accuracy			Total
			1 – 3	4	5	
Sex	Male	Count	14	38	57	109
		% within Sex	12.8%	34.9%	52.3%	100.0%
	Female	Count	7	26	48	81
		% within Sex	8.6%	32.1%	59.3%	100.0%
Total		Count	21	64	105	190
		% within Sex	11.1%	33.7%	55.3%	100.0%

Table E3:

The relationship between saccadic (accuracy) and gender:

Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.256(a)	2	.534
Likelihood Ratio	1.273	2	.529
Linear-by-Linear Association	1.233	1	.267
N of Valid Cases	190		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.95.

Table E4:

The relationship between saccadic (accuracy) and age

Crosstab

			(R)Saccadic: Accuracy			Total
			1-3	4	5	
(R)Age	8 - 10	Count	12	38	75	125
		% within (R)Age	9.6%	30.4%	60.0%	100.0%
	11 - 13	Count	9	27	30	66
		% within (R)Age	13.6%	40.9%	45.5%	100.0%
Total		Count	21	65	105	191
		% within (R)Age	11.0%	34.0%	55.0%	100.0%

Table E5:

The relationship between saccadic (accuracy) and age:

Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.704(a)	2	.157
Likelihood Ratio	3.698	2	.157
Linear-by-Linear Association	3.182	1	.074
N of Valid Cases	191		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.26.

Table E6:

Cumulative frequency distribution of pursuit eye movements

(R)Pursuits: Head	**Count**	23	85	83	191
	%	12.0%	44.5%	43.5%	100.0%
(R)Pursuits: Accuracy	**Count**	31	71	89	191
	%	16.2%	37.2%	46.6%	100.0%
(R)Pursuits: Ability	**Count**	21	65	105	191
	%	11.0%	34.0%	55.0%	100.0%

Table E7:

The relationship between pursuits (accuracy) and age

Crosstab

			(R)Pursuits: Accuracy			**Total**
			3 - 5	**4**	**5**	
(R)Age	**8 - 10**	**Count**	23	42	60	125
		% within (R)Age	18.4%	33.6%	48.0%	100.0%
	11 - 13	**Count**	8	29	29	66
		% within (R)Age	12.1%	43.9%	43.9%	100.0%
Total		**Count**	31	71	89	191
		% within (R)Age	16.2%	37.2%	46.6%	100.0%

Table E8:

The relationship between pursuit (accuracy) and age:

Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.444(a)	2	.295
Likelihood Ratio	2.466	2	.291
Linear-by-Linear Association	.039	1	.843
N of Valid Cases	191		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 10.71.

Table E9:

The relationship between pursuit (accuracy) and gender

Crosstab

			(R)Pursuits: Accuracy			Total
			1-3	4	5	
Sex	Male	Count	20	40	49	109
		% within Sex	18.3%	36.7%	45.0%	100.0%
	Female	Count	11	30	40	81
		% within Sex	13.6%	37.0%	49.4%	100.0%
Total		Count	31	70	89	190
		% within Sex	16.3%	36.8%	46.8%	100.0%

Table E10:

The relationship between pursuit (accuracy) and gender:

Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.844(a)	2	.656
Likelihood Ratio	.855	2	.652
Linear-by-Linear Association	.726	1	.394
N of Valid Cases	190		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 13.22.

Table E11: Fixation ability

(R)Motility: Fixation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Weak / Adequate	17	8.9	8.9	8.9
	Strong	88	45.8	46.1	55.0
	Very Strong	86	44.8	45.0	100.0
	Total	191	99.5	100.0	
Missing	System	1	.5		
Total		192	100.0		

Table E12:

The relationship between fixation ability and gender

Crosstab

			(R)Motility: Fixation			Total
			Weak / Adequate	Strong	Very Strong	
Sex	Male	Count	9	58	42	109
		% within Sex	8.3%	53.2%	38.5%	100.0%
	Female	Count	7	30	44	81
		% within Sex	8.6%	37.0%	54.3%	100.0%
Total		Count	16	88	86	190
		% within Sex	8.4%	46.3%	45.3%	100.0%

Table E13:

The relationship between fixation ability and gender:

Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.192(a)	2	.075
Likelihood Ratio	5.222	2	.073
Linear-by-Linear Association	1.471	1	.225
N of Valid Cases	190		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.82.

Table E14:

The relationship between fixation ability and age

Crosstab

			(R)Motility: Fixation			Total
			Weak / Adequate	Strong	Very Strong	
(R)Age	8 - 10	Count	14	50	61	125
		% within (R)Age	11.2%	40.0%	48.8%	100.0%
	11 - 13	Count	3	38	25	66
		% within (R)Age	4.5%	57.6%	37.9%	100.0%
Total		Count	17	88	86	191
		% within (R)Age	8.9%	46.1%	45.0%	100.0%

Table E15:

The relationship between fixation ability and age:

Chi-Square Test

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.189(a)	2	.045
Likelihood Ratio	6.382	2	.041
Linear-by-Linear Association	.033	1	.855
N of Valid Cases	191		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.87.

Table E16:

The relationship between fixation ability and age:

Cramer's V

Symmetric Measures			
		Value	**Approx. Sig.**
Nominal by Nominal	**Phi**	.180	.045
	Cramer's V	.180	.045
N of Valid Cases		191	
a Not assuming the null hypothesis.			
b Using the asymptotic standard error assuming the null hypothesis.			

ANNEXURE A

RECORD CARD FOR RESEARCH

NAME:

DATE:

D.O.B:

Y	Y	Y	Y	M	M	D	D

GENDER:

Male		Female	

NAME OF SCHOOL:

PD:

VA:

@ 6m RE: LE: BE:

@ 40cm RE: LE: BE:

STEREOPSIS:

REFRACTIVE ERROR:

STATIC RETINOSCOPY:

RE: VA: LE: VA:

Hyperopic		Myopic		Astigmatic		Emmetropic	

ACCOMMODATION:

AMPLITUDE (Donder's push up):

RE:........................ LE:......................

RESPONSE (MEM):

RE:....................... LE:......................

FACILITY (Flippers):

RE:.......... cpm LE:.............. cpm

BE:.......... cpm

<u>OCULAR MOTILITIES:</u>

POSITION MAINTANANCE:

V/strong		Strong		Adequate		Weak		Very weak	

PURSUITS:

Head/body movement		Accuracy		Ability	

SACCADICS:

Head/Body movement		Accuracy		Ability	

<u>VERGENCE:</u>

NEARPOINT OF CONVERGENCE:

Break		Recovery	

COVER TEST:

UNILATERAL /ALTERNATING (6m):

UNILATERAL /ALTERNATING (40cm):

SMOOTH VERGENCE (Amplitude):

NEAR (40cm):

Base in:

Blur	Break	Recovery

Base out:

Blur	Break	Recovery

VERGENCE FACILITY:

OCULAR HEALTH

INTERNAL

Lens: ....

Vitreous:..............................

Fundus:................................

Cup/disc:..............................

Vessels:.................................

EXTERNAL EXAMINATION:

Pupillary reflexes:

Direct:..................................

Consensual:............................

ANNEXURE B

RANDSE AFRIKAANSE UNIVERSITEIT
Departement Vervoer- en Logistieke Bestuur
Posbus 524, Auckland Park 2006
Johannesburg, Republiek van Suid-Afrika
Tel + 27 (011) 489 2911 (RAU Skakelbord)
Faks + 27 (011) 489 2029 / 2972

R A U

RAND AFRIKAANS UNIVERSITY
Department of Transport and Logistics Management
PO Box 524 Auckland Park 2006
Johannesburg Republic of South Africa
Tel + 27 (011) 489 2911 (RAU Switchboard)
Fax + 27 (011) 489 2029 / 2972

FACULTY OF SCIENCE

Tel No: +27 11 489 2471
Fax No: +27 11 489 3207
Email: ns@na.rau.ac.za

19 November 2003

TO WHOM IT MAY CONCERN

PREVALENCE OF VISUAL PROBLEMS IN CHILDREN WITH LEARNING DISABILITIES IN GAUTENG

The abovementioned project proposal was studied by the committee for Academic Ethics and approved.

ANNEXURE C

INFORMED CONSENT FORM

TITLE OF THE RESEARCH: PREVALENCE OF VISUAL PROBLEMS IN CHILDREN WITH LEARNING DISABILITIES IN JOHANNESBURG.

PRINCIPAL INVESTIGATOR: **PHONE:** (011) 406- 8488

Thokozile. I. Metsing (B.Optom)
Department of Optometry
Technikon Witwatersrand
P.O. Box 17011
Doornfontein 2028

I, ____ agree to allow my child to participate in a research project conducted at ____________________ clinic/school, investigating the visual problems that could be related to learning disabilities.

I understand that the study involves several procedures where:

1. The child's eyesight will be evaluated.
2. The child's eye alignment will be evaluated by occluding each eye and observing the eye movements.
3. Lenses will be put in front of the child's eye to evaluate the focusing ability.
4. Light will be shined into the child's eyes to assess refractive status and the health status of the eyes.

I understand that the procedures will last for approximately 25 minutes, and the child may be asked to return for an additional session if data cannot be obtained in a single session.
I understand that participation in this study is voluntary and I can withdraw my child at any time.
I agree that the information obtained from this study can be used for educational and publication purposes, provided the information is coded so as to protect the identity of my child.
If I have any questions or problems that arise in connection with participation in this study, I will contact Ms. Ingrid Metsing at (011) 406-8488 or 0827894644.

______________________________ ______________________________
Parent(s) signature(s) Date:

______________________________ ______________________________
Investigator signature Date: