EFFECTIVENESS OF ADDITIONAL COMPUTER-BASED INTERVENTION FOR THE REMEDIATION OF VISUAL PERCEPTUAL SKILLS IN 7 to 9 YEAR OLD LEARNERS DIAGNOSED WITH ATTENTION DEFICIT HYPERACTIVITY DISORDER

Fransli Buckle

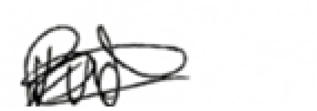
A thesis submitted to the Faculty of Health Sciences, School of Therapeutic Sciences, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Doctor of Philosophy.

Johannesburg

2019

Declaration

I, Fransli Buckle, hereby declare that this thesis is my own work. It is being submitted for the degree of Doctor of Philosophy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other university.



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(Signature candidate)

___________6_____Day of _____June___________________, 2019.

Dedication

This thesis is dedicated to David and Karin Smith for teaching me from a young age to contribute and make an impact on society. They taught me to have a dream and the importance of making it reality. They always believed in me and set high expectations. The completion of this thesis was a journey and a marathon well completed. My dream is that this research project assists clinicians to improve the occupational performance of learners diagnosed with ADHD.

"A journey of a thousand miles begin with a single step"

Chinese proverb

Publications and Presentations arising from this study

Conference presentations

Buckle F, Franzsen D and Potterton J. (2016) The effectivenss of mulitmedia visual perceptual training for children with disabilities: A systematic review. *35th National congress of the Occupational Therapy Association of South Africa (OTASA).* Johannesburg.

Buckle F, Franzsen D and Potterton J. (2018a) The effectivenss of mulitmedia visual perceptual training for children with disabilities: A systematic review. *17th International Congress of the World Federation of Occupational Therapists (WFOT).* Cape Town.

Buckle F, Franzsen D and Potterton J. (2018b) Personalised learning and creating unique curriculms. *EduTECH Africa.* Johannesburg.

Buckle F, Franzsen D and Potterton J. (2018c) Tech as a tool. *EduTECH Africa.* Sandton Convention Centre.

Acknowledgments

- To my supervisors Dr. Franzsen and Prof Potterton, for giving your time. Your support, motivation and guidance are much appreciated.
- To Prof. Margot Graham and PhD support group for your ongoing motivation.
- To Mr. du Preez for supporting this research project.
- To the participants in the study, thank you for assisting us in providing evidence.
- To my husband, Pieter Buckle, for your insight, unconditional love, support and understanding during this journey.
- To our children, Lodewyk and David Buckle, who were born during this journey, thank you for your patience and love. May you remember this journey and I hope the memories of this journey will also accompany you on your life path.
- To my good friend Stefanie van Dyk, for always encouraging me and sharing a passion to have a positive impact on the lives of learners diagnosed with ADHD.
- To my friend and colleague Sandra for asking the “so what?” question and assisting with developing my critical thinking skills.
- To my siblings, Jacques, Dawie, Janis and Madeli Smith, for your support and encouragement.
- To my colleague Mrs. Lombard, for support and pointing out the importance of visual attention during the writing process.
- To my colleague Mr. Theron, for your interest, support, motivation and encouragement.
- To my parents-in-law, Theuns and Hantie Buckle, thank you for your ongoing support, love and interest.
- To Dr. Paula Barnard-Ashton for her advice, motivation and technical support.
- To Armandi for opening up the world of occupational therapy to me, shaping my worldview and influencing my career choice.

Soli Deo Gloria

Abstract

Purpose: The purpose of the study was to examine the intervention of visual perceptual problems in learners diagnosed with ADHD using computer technology. Learning, embedded with stepped levels of visual perceptual skills, can be reinforced in a spontaneous and playful manner through using technology. Phase 1 aimed at identifying the most prevalent visual perceptual dysfunction within the population. Thereafter in Phase 2 an intervention criteria was established to assist with the selection of the most appropriate software for the remediation of visual perceptual skills in learners diagnosed with ADHD. The purpose of the intervention criteria was to contribute to the fidelity of the intervention. Finally the effectiveness of the selected computer-based visual perception intervention programme was evaluated in Phase 3.

Method: Intervention research design was implemented. The study consisted of three phases. Phase 1 included a record review to identify the most prevalent visual perceptual problems within a sample of children with ADHD. This assisted the researcher to identify the "at risk" visual perceptual constructs that were included in a treatment programme. Phase 2 involved reviewing the literature to identify essential criteria to be included in a visual perception intervention programme. A workshop was presented to experts in the field of visual perception, and content included results of Phase 1, treatment principles, grading principles and activity ideas identified in the literature. The nominal group technique (NGT) followed the workshop to establish the essential intervention criteria required of a computer-based visual perception intervention programme for learners diagnosed with ADHD. An intervention criteria checklist was developed with the participants of the nominal group and this was used to evaluate computer-based programmes which addressed visual perceptual skills. The most suitable computer-based programme was selected, with confirmation by one expert. Phase 3 involved evaluating the effectiveness the selected programme. A longitudinal crossover research design, which is a repeated measurement design, was employed in Phase 3.

Results: Phase 1 illustrated that learners diagnosed with ADHD have special educational needs due to their barriers of learning. Their performance at school is less effective than a normative sample (peers) in visual perceptual tasks due to poor

visual attention and impulsivity. It was also highlighted that ocular-motor function should be assessed and intervention should be provided for visual perceptual dysfunction in learners diagnosed with ADHD. The most prevalent visual perceptual problems in learners diagnosed with ADHD that was included in the record review were visual discrimination, visual closure, visual spatial relations and visual memory. This impacts on their academic outcomes such as reading and maths and results in lower academic results than their typical peers.

Phase 2 emphasised the importance of the integration of clinical reasoning and literature to provide sound evidence that can support evidence-based practice. Grading and treatment principles are essential for ensuring the fidelity of the intervention. Explicit practice principles, goals and activities as well as the need for intervention are essential components in intervention research. Phase 2 demonstrated that there are various computer-based software treatment options available. However not all computer-based software treatment options are equal and it is therefore important to follow scientific guidelines in the selection of the most suitable computer programme for the remediation of visual perceptual skills in 7-9 year old learners diagnosed with ADHD.

The intervention criteria checklist developed using a NGT resulted in each intervention criterion being allocated a weighting and which were used with a computer software evaluation form to select the *Sea World Adventures*™ computer programme that scored 84% of the identified intervention criteria.

Phase 3 provided evidence that using an integration of traditional intervention in combination with technology can yield successful results. The within group results for Group 1 and 2 for Beery VMI, motor coordination, the visual perception, all TVPS-3 index scores (overall, basic processes, sequencing and complex processes) and scholastic assessment (reading, addition and subtraction) proved that additional computer-based intervention can have a significant impact. Between group results indicated that significant differences were obtained between Groups 1 and 2 for the scores on the Beery VMI test for VMI and the visual perception during Assessment 2, indicating the effectiveness of intervention A (additional computer-based intervention) for Group 1. Reading was the only scholastic assessment that yielded significant results in Assessment 2 for Group 1 compared to Group 2 after the additional computer-based intervention.

This study illustrated that technology is an ideal intervention tool for children diagnosed with ADHD. Feedback provided by technology is immediate, multisensory and therefore reinforces rapid learning. Technology is evolving and a meaningful tool that can be used to promote learning and development. It should be used with judgement and careful selection. Caution should be applied to the intensity and frequency of usage and it should be closely monitored. Computer programmes that are used for the remediation of visual perceptual skills should be used in collaboration with other approaches such as occupational therapy. Learners should be exposed to a variety of activities on both a three dimensional and two dimensional level for the acquisition of visual perceptual skills if these are to be successfully integrated into their academic performance in the classroom.

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Operational Definitions

Attention Deficit Hyperactivity Disorder:

Attention Deficit Hyperactivity Disorder is described as a prolonged behavioural pattern of inattention and/or hyperactivity-impulsivity that has a negative impact on functioning or development (American Pschyiatric Association, 2013)

Client factors:

*Client factors “*are specific capacities, characteristics, or beliefs that reside within the person and that influence performance in occupations” (American Occupational Therapy Association, 2008)

Inclusive education:

Inclusive education is acknowledging that every individual can learn and has a right to access the education system. The policy highlights that specialized support should be provided for individuals with barriers to learning (South African and Education Department, 2001).

Occupation:

Occupation is described as everyday life activities humans engage in. (American Occupational Therapy Association, 2008)

Occupational performance:

“A dynamic relationship among an occupational form, a person with a unique developmental structure, subjective meanings and purpose, and the resulting occupational performance” (Nelson and Jepson-Thomas, 2003: 90)

Performance Skills:

Performance skills are the client’s demonstrated abilities (American Occupational Therapy Association, 2008)

Visual Closure:

Visual closure is the skill to recognise forms or objects from partial presentations (Schneck, 2010b).

Visual Discrimination:

Visual discrimination is an integrated skill that requires recognition, finding similarities and categorisation the features of visual stimuli (Martin, 2006; Schneck, 2010a).

Visual Memory:

Visual memory is the integration of visual information and prior life experiences and consists of long-and short-term memory (Schneck, 2010b).

Visual Perception:

Visual perception is defined as the "total process responsible for the reception (sensory functions) and cognition (specific mental functions) of visual stimuli" (Schneck, 2010b) .

Visual Spatial Perception:

Spatial perception can be differentiated into spatial relations and position in space (Schneck, 2010b). Position in space is the ability to identify objects in relation to oneself or other objects (Schneck, 2010a; Schneck, 2010b). Spatial perception is essential in comprehending directional language such as in, out, up, down, front, back, left and right (Schneck, 2010a).

Intervention Principle:

According to the OTPF III intervention principles are the theories and knowledge that guide intervention and clinical reasoning (American Occupational Therapy Association, 2014)

Grading Principles:

Grading principles are principles that can be applied to activities with the purpose to increase or decrease the complexity of execution (Case- Smith, 2015).

Abbreviations

AAP	American Academy of Paediatrics
ADHD	Attention Deficit Hyperactivity Disorder
CAI	Computer Assisted Instruction
CAPS	Curriculum and Assessment Policy Statement
CAT	Computerized Attention Training
CAVP	Componential Assessment of Visual Perception
CAMHS	Child and Adolescent Mental Health Services
DSM V	Diagnostic and statistical manual of mental disorders 5th edition
DTVP-3	Developmental test of visual perception skills third edition
GBATS	Game-Based Auxiliary Training System
ICF	International Classification of Functioning
LSEN	Learners with special educational needs
NGT	Nominal Group Technique
OBE	Outcomes-Based Education
OTPFIII	Occupational Therapy Practice Framework: Domain and Process 3nd Edition
SEM	Standard error of measurement
SIAS	Screening, identification, assessment and support
SNA	Support Needs Assessment
TVPS-3	Test of visual perceptual skills third edition
VMI	Visual Motor Integration
WHO	World Health Organization

WFOT	World Federation of Occupational Therapists

CHAPTER 1
INTRODUCTION

"If someone wants to know what ADHD feels like give them some math problems and throw firecrackers at their feet."

-Unknown

1.1 INTRODUCTION AND BACKGROUND

Learners diagnosed with barriers to learning are often diagnosed with specific learning disabilities, which can be due to Attention Deficit Hyperactivity Disorder (ADHD. Learners with ADHD often present with deficits in educational and school related tasks such as copying from the black board, word recognition, spelling, ordering of letters and numbers and spacing, size and letter formation in handwriting. All of these tasks are related to attention and visual perception and resolving deficits in these performance skills and client factors are important because it impacts on the learners' ability to function at the level expected. These learners are often frustrated due to challenges they experience in participating in their role as learners and in achieving academic success (Loe and Feldman, 2007). This can be attributed to barriers of learning and lack of support learners with ADHD encounter within the traditional school setting. Statistics from the United States estimate that *8%* of children between 3-17 years of age are diagnosed with ADHD (Bloom et al., 2009). There are currently no data availible on the prevelance of ADHD in South Africa.

The South African Department of Education acknowledged and identified the needs of these learners and proposed that learners with barriers to learning should have access to special educational when they released White paper 6 on special needs education in 2001 (South African and Education Department, 2001). As a result, the South African Department of Basic Education (2014) drafted a policy on screening, identification, assessment and support (SIAS) for learners with barriers to learning; this document was published in 2014. The purpose of this policy was to facilitate and enhance inclusive education (Department of Basic Education, 2014). This inclusion model highlights the importance of initial identification of disabilities and support in the Foundation Phase (Gr 1-3) of education (South African and Education Department, 2001). The Department of Education stated that as part of their White Paper 6 strategy they will establish and develop early identification, assessment and support programmes for learners diagnosed with special educational needs in the age group 0 to 9 years (South African and Education Department, 2001). Including learners aged 7-9 years in this study could therefore assist in supporting early childhood development and the inclusion policy for education outlined in White Paper 6 (South African and Education Department, 2001). The importance of including this age group in the study was further supported by literature that confirmed that optimal visual perceptual development takes place between 8 and 10 years of age. This is a crucial developmental period for visual perceptual development in learners for the acquisition of academic skills and perceptual skills that are acquired in the foundation phase (Gr 1-3) are important for developing executive functioning skills in the intermediate phase (Gr 4-6) (Schneck, 2010b; Vlok et al., 2011a).

One of the strategies suggested to overcome the lack of individual therapy is the introduction of computer technology. Well-designed computer-based programmes could be used within the educational setting as a tool for occupational therapy remediation or rehabilitation of performance skills and client factors related to visual perception. Emerging visual and digital technologies have reshaped learning (Ross, 1992). Research as early as 1995, showed that even then the average high school graduate in the United States of America spent 11 000 hours per year in school and 16 000 in front of a TV or computer screen (Monnes-Hattal, 1995). This is also true in the South African context with the increase of emerging digital technology and the use thereof within the educational setting, therefore suggesting that computer-based technology may be a suitable form of visual learning (Halton, 2008).

The adaption or appropriate selection of software to support remediation of client factors related to visual perception and visual motor integration, needed in the classroom could therefore be used in occupational therapy to promote, improve or maintain the ability of children to engage in academic activities in a meaningful way (Halton, 2008; Schoonover and Argabrite Grove, 2015). This is feasible as access to computers and technologies is increasing and is available in LSEN schools.

1.2 PHILOSOPHICAL PERSPECTIVE FOR THIS STUDY

The philosophical perspective is an important element in this thesis required to support the assumptions and understanding visual perception from an occupational therapy perspective as well as the intervention strategies and the implementation of these for deficits in visual perception. In order to explain the philosophical basis for this study ontology, epistemology and axiology were considered.

1.2.1 Ontology

Hooper and Wood 2014 described ontology by the question " What is most real?" (Hooper and Wood 2014):36). Within the research perspective, ontology can be described as distinguishing reality that can be explored and constructed through human interactions and meaningful actions (Hooper and Wood 2014):37). In this study, learners will be viewed as occupational beings (Wilcock, 2000). Clark (1997) reflected on humans as occupational creatures, with a biological requisite for occupation. Education is viewed an essential human occupation and a cornerstone for development and survival later in life (Clark, 1997; Wilcock 1993). Visual perception contributes to the occupation of education in providing the foundation for educational skills such as writing, mathematics and reading.

The ontology perspective of occupation includes that humans are interconnected with their environments (Hooper and Wood 2014). Within a fast-changing society and evolution of technology, it is important to explore alternative environments for the treatment of visual perceptual skills. Children born in the 21st century are more familiar with technology for leisure and education purposes, therefore using a multimedia environment for the remediation of skills related to the occupation of education might be beneficial. Ontological approaches recognise that although humans are interconnected with their environments they need to transform by their actions and adapting their environments (Hooper, 2006). Exploring alternative environments and strategies for the treatment of visual perceptual skills is therefore in line with ontological assumptions. This question can be answered by viewing the bottom up approach in accordance with the research paradigm of visual perceptual skills. The bottom-up approach is hierarchical and based on neuroscience theories of the 1970s and 1980s (Case- Smith, 2015).

1.2.2 Epistemology

Epistemological developments assist researchers to evaluate assumptions and determine new approaches (Hooper, 2006). Hooper and Wood (2014) described epistemology by asking the question "What is knowledge" (Hooper and Wood 2014):37). They recommended the epistemology for this study can be understood by examining the most important knowledge and how it is acquired, used and organised (Hooper and Wood 2014). Theories of visual perception can be extracted from various fields such as anatomy, physiology, psychology, neurology and education. An important aspect of epistemology is the structure of knowledge (Hooper and Wood 2014). Visual perception has various structure elements, such as different subtypes that are inter-related (Martin, 2006). Literature also confirmed there is a hierarchal development of visual perceptual skills (Warren, 1993). Subtypes, hierarchical structures and various theories of visual perceptual skills will be discussed and critically evaluated in Chapter 2.

1.2.3 Axiology

In order to comprehend axiology, the following question should be asked "What is the right action in research on the development of visual perceptual skills?" (Hooper and Wood 2014):36). Due to the dynamic changes in humans, occupations and environments, it is important to collaborate with clients as an essential principal of practice (Hooper and Wood 2014). Changes and advancement in technology mean that learners from Grade 1 are exposed to multimedia technology as part of their daily activities in participation of the occupation of education. The right action would therefore be to evaluate the effectiveness of different media for the remediation of visual perceptual skills. Evidence-based practice would also support the axiology in creating experiences of occupational performance where people can experience well-being.

1.2.4 Theoretical Perspective relating to Ontology, Epistemology and Axiology

Various epistemological positions will be explored in order to find the most appropriate worldview for this research study; post-positivism, constructivism and pragmatism will be considered. In mixed methods research, it is common to have more than one worldview (Creswell and Plano Clark 2018). Research of a quantitative nature, with variables and empirical values that can be measured, is often associated with positivism or post-positivism worldview (Creswell and Plano Clark 2018; O`Connor and Netting, 2011). The philosophy of positivism and post-positivism is similar, it is just the matter of degree that differs(Creswell and Plano Clark 2018); it is philosophically paired (O`Connor and Netting, 2011). O`Connor and Netting (2011) described the ontology of positivism as realist and post positivism is described as critically realist. The ontology is also described as a single reality relating to hypothesis (Creswell and Plano Clark 2018). The core outcome of this study is to test the reality of the effectiveness of computer programmes for the intervention of visual perceptual skills of learners diagnosed with ADHD. Although other outcomes contribute to occupational therapy, the main focus allows for a single reality to be adopted. Pragmatism would be the alternative worldview should there be findings of other outcomes that require further exploration. Pragmatism allows singular and multiple perspectives and is recommended for mixed methods research methodology (Creswell and Plano Clark 2018). Should this worldview be more favourable, it will be discussed in the final chapter of this thesis. (Killiam, 2013). It is possible for the worldview to shift in another phase of the study if more qualitative methods are used, for example nominal groups (Creswell and Plano Clark 2018).

Constructivism is a worldview that is more likely to be accepted in Phase 2 (Identification of intervention criteria and computer programme selection) of the study due to the acceptance of multiple realities (Creswell and Plano Clark 2018). Constructivism approaches are more suitable for focus groups because meanings are derived from participants to gain more insight in the research question (Creswell and Plano Clark 2018). In Phase 2, the researcher needed to account for different perspectives and use sound clinical reasoning to determine the intervention criteria and select the most appropriate computer programme.

From an epistemological perspective positivism and post positivism should be considered. Positivism can be described as an objective stance and post positivism is defined by using an analytical objective approach in viewing reality (O`Connor and Netting, 2011). The focus of post-positivism is laws, which in science is the only truth (Creswell and Plano Clark 2018). Emphasis is placed on cause and effect and that phenomenon can be controlled and predicted through validation (Creswell and Plano Clark 2018). The validation of this research study (Phases 1 and 3) is conducting standardised assessments and statistical analysis to measure the progress and to determine if the hypothesis will be accepted. Quantitative measures of data collection in this research study contribute in maintaining an objective approach. In Phases 1 and 3, each participant was assigned a code to assist the researcher to collect data objectively. A negative aspect of this worldview is the reductionist nature and research is dependent on specific variables and controlled measurements. These principles are in line with empirical scientific methods of research. The principles were used by the researcher to observe, investigate, and understand the learning process through strategies such as participant observation and standardised tests. The principles were implemented in a context in which the learning occurs. Accepting a post-positivism worldview is instrumental when considering evidence-based practice because of the empirical nature of the study (Creswell and Plano Clark 2018; Law and Mac Dermid 2014).

Axiological assumptions for post-positivism worldviews include the belief in quality research, and randomised experiments are valued due to their ethical nature. An element of the axiology of post-positivism is unbiased research. The researcher controls and eliminates possible bias by implementing measures to reduce the possibility of bias. The therapist, who conducted the intervention in Phase 3 was blinded and did not see the results of assessment. The therapist conducting the assessments did not know the names of the children because a code was assigned .

1.3 RESEARCH QUESTION

Will a commercially available computer programme meet the intervention criteria for specific visual perceptual deficits, be effective in the treatment of visual perceptual dysfunction in 7 to 9 year old learners diagnosed with ADHD.

1.4 AIM OF THE STUDY

This research project was completed in three phases; the aims and objectives are indicated below.

Phase 1

Identification of visual perceptual dysfunction in learners with ADHD

Aim: To determine the dysfunction in visual perceptual in learners between 7 to 9 years old diagnosed with ADHD at a LSEN School.

Objective:

- To determine the most frequent dysfunction in visual perception in 7 to 9 year old learners with ADHD at a LSEN School.

Phase 2:

Identification of intervention criteria and computer programme selection

Aim: To establish intervention criteria based on a theoretical foundation for the selection of the most suitable computer programme for the intervention of visual perceptual dysfunction in 7 to 9 year old learners with ADHD.

Objectives:

- To determine the theoretical foundation of intervention (treatment principles, grading and activity ideas) to be used with visual perceptual constructs.
- To establish intervention criteria that can be used in the selection of a computer programme for the intervention of visual perceptual dysfunction identified in 7 to 9 year old learners diagnosed with ADHD in Phase 1.
- To review and select the most suitable commercially available computer programme to address the visual perceptual dysfunction identified in 7 to 9 year old learners diagnosed with ADHD.

Phase 3:

Evaluation of computer-based intervention

Aim: To establish the efficacy of a computer-basedintervention on the visual perceptual dysfunction and academic functioning in 7 to 9 year old learners diagnosed with ADHD.

Objectives:

- To determine the change in visual perceptual functioning, on standardised tests of visual perception and academic functioning, to evaluate the effectiveness of the computer-based intervention for 7 to 9 year old learners diagnosed with ADHD.

- To make recommendations about the essential criteria for the selection of effective computer programmes for the intervention of visual perceptual dysfunction in 7 to 9 year old learners diagnosed with ADHD.

1.5 JUSTIFICATION OF THE STUDY

The World Occupational Therapy Federation (WFOT) identified technology and occupational therapy as a research priority which aligns with the strategic goals of the World Health Organization (WHO). This Federation views technology as emerging and impacting on the everyday occupations of people. They consider technology to be either facilitating or detrimental to occupational performance. The scope of research that they recommend covers how technology is used by occupational therapists in their practice and the participation of clients in occupations using technology (World Federation of Occupational Therapists et al., 2017).

There is limited research providing evidence on the effectiveness of occupational therapy intervention, including computer-based programmes, for visual perception and the resultant effect on the occupation of education in terms of academic performance of learners. This includes a lack of information on the intensity and frequency of therapy needed to remediate visual perceptual problems in learners with learning disabilities, particularly those diagnosed with ADHD. There is no research available on the use of computer-based intervention for learners diagnosed with Attention Deficit Hyperactivity Disorder for the remediation of visual perceptual skills.

No published research about the specific visual perceptual deficits of learners diagnosed with ADHD in South Africa could be found; therefore, it is unknown what aspects of visual perception are of particular concern with these learners and what specific client factors and performance skills need to be addressed. There is also a gap in research evidence on the impact of computer-based programmes in the remediation of visual perceptual skills in children diagnosed with ADHD. More evidence is required that relates to what features of computer gaming activities contribute to the perceived positive impact in motivation and inhibitory response of ADHD children (Shaw et al., 2005) .

Occupational therapists can contribute to service delivery within the education system should they recommend effective programmes to be implemented. Currently visual perception is addressed within LSEN schools in small groups of two to three learners using three dimensional or table top (worksheet) activities. The implementation of computer-based programme intervention could assist in the reduction of barriers to learning in more learners (larger groups) diagnosed with ADHD. This would ensure that more learners gain access to services and intervention.

1.6 OUTLINE OF THESIS

Figure 1.1 illustrates the various phases of the study and the purpose of each phase. Thereafter the chapter outline will be discussed.

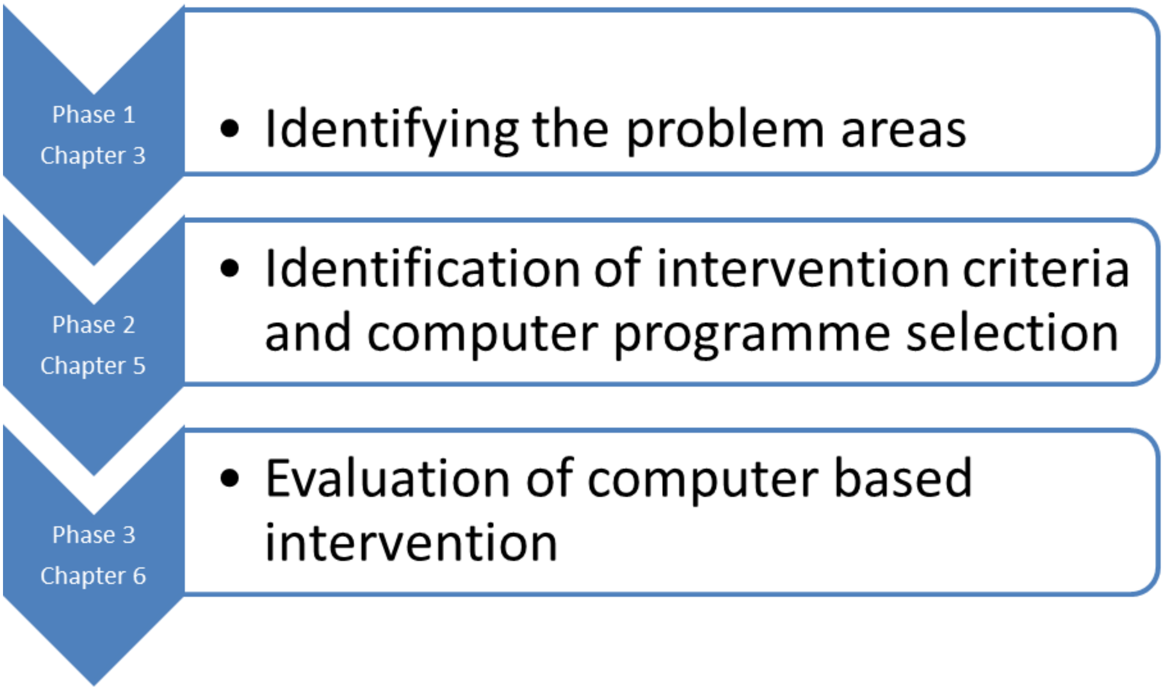

Figure 1.1: Phases of the study

1.6.1 Chapter 1 Introduction to the study

Chapter 1 includes the introduction, background, philosophical frameworks and statement of the problem, the purpose and justification for the study.

1.6.2 Chapter 2 Literature Review

Chapter 2 includes the literature review. The following aspects are covered: occupation, factors occupational therapist often consider for school-based therapy, factors impacting on learners with learning disability within the school setting, the visual system and visual perception, assessment and intervention of visual perception and using technology.

1.6.3 Chapter 3 Phase 1: Determine the problem areas

Chapter 3 includes general methodological introduction, data collection, results and discussion of Phase 1(Identification of visual perceptual dysfunction in learners with ADHD).

1.6.4 Chapter 4- Phase 2: Identification of intervention criteria and computer programme selection

Chapter 4 includes data collection, results and discussion of Phase 2 (Identification of intervention criteria and computer programme selection).

1.6.5 Chapter 5 -Phase 3: Evaluation of computer-based intervention

Chapter 5 includes data collection, results and discussion of Phase 3 (Evaluation of computer-based intervention).

1.6.6 Chapter 6-Discussion Phase 1-3

Chapter 6 contains the discussion of all three phases of the study.

1.6.7 Chapter 7-Conclusion and recommendations

Chapter 7 is the final chapter containing the summary, conclusion, recommendations, implications for the study and future research.

CHAPTER 2: LITERATURE REVIEW

"The ADHD brain is like a Ferrari engine…. with bicycle brakes"

Dr. Ned Hollowell

2.1 INTRODUCTION

A diverse range of literature was obtained from various fields, such as occupational therapy, occupational science, psychology, sociology, education, anatomy, physiology, neurology, visual therapy, optometry and psychiatry. Literature was sourced from various databases, such as Pro-Quest, Pub Med, PubPsyc, SpringerLink, WorldCat, OTseeker, PsycInfo, Science Direct, as well as the SAGE journal database. The following key words were used: occupational therapy; Attention Deficit Hyperactivity Disorder; visual perception; inclusive education; assessment; intervention; technology in education. Literature was sourced from 1953 up to 2018; the older literature had to be included because it serves as classical theoretical knowledge that is a baseline for research.

Literature was explored to illustrate the significance of schoolwork as an occupation in occupational therapy as well as the elements of visual perception, which may restrict the capability to achieve success within the school environment. Specific emphasis was on visual perceptual deficits in ADHD. The assessment and intervention of ADHD related to facilitating school performance, inclusive of interventions using multimedia to improve visual perceptual dysfunction, were also considered.

2.2 OCCUPATION AND FACTORS OCCUPATIONAL THERAPISTS COMMONLY CONSIDER IN EDUCATION BASED INTERVENTION

The WFOT describes occupation as the ordinary activities people participate in on a daily basis which occupy time and contribute to life's meaning and purpose (World Federation of Occupational Therapists, 2003). Ann Wilcock (1993) supported the participation of any child in occupations as a significant part of the human experience.

> “All people need to be able or enabled to engage in the occupations of their need and choice, to grow through what they do, and to experience independence or interdependence, equality, participation, security, health, and well-being (Wilcock, 1993):198).

Occupation, as an ontological perspective, provides greater insight into the occupational therapy profession (Hooper and Wood, 2014). The Occupational Therapy Practice Framework III also contributes to this fundamental belief in the profession as the significant collaboration between occupation and health and perceiving humans as occupational beings (American Occupational Therapy Association, 2008). The framework indicates that one of the major domains of occupation is education and that occupations should be considered within their contexts as well as considering the integration of client factors, performance skills and performance patterns (American Occupational Therapy Association, 2008).

This study addressed the essential occupational performance area of education, which includes all activities that are required of learning and participation within an education environment to achieve academically (American Occupational Therapy Association, 2008). Academic achievement can be viewed as the outcome of participating in education as an occupation. Learning in the foundation level in school includes reading, writing and mathematics; these activities are goal directed and meaningful in which learners participate (Parham, 2002). Client factors, or body structures and functions, as outlined by the International Classification of Functioning (ICF)(World Health Organization, 2001), and performance skills, as outlined by the Occupational Therapy Practice Framework: Domain and Process 3nd Edition (OTPFIII), are key elements required for occupational performance and therefore successful participation in the classroom (American Occupational Therapy Association, 2008). Occupational therapy literature has identified various unique and diverse prerequisite client factors and performance skills that should be consolidated for children to achieve these academic goals and to function optimally (Case-Smith and Rogers, 2005).

Under the classification of client factors, or body structures and functions, and performance skills, a learner needs mental as well as cognitive performance skills to participate in academic activities (American Occupational Therapy Association, 2008; Case-Smith and Rogers, 2005). The mental functions needed include higher cognitive skills, attention, vision, visual acuity, visual stability, thought, perception, emotion, memory, sequencing, integrated movement and experience of self and time. Client factors can be influenced by the manifestation of deficits and can in turn affect performance skills (Smith Roley et al., 2008). Hence, client factors need to be intact for learners to follow through on actions (performance skills) and to develop the performance skills required to participate in occupations (American Occupational Therapy Association, 2008).

Performance skills are goal driven actions used to locate, identify, and respond to sensations and to select, interpret, associate, organise, and remember sensory events (American Occupational Therapy Association, 2008). These skills include visual perceptual, sensory motor and fine motor skills required for activities such as reading, writing, following of instructions and doing maths, and are required for optimal function within the classroom environment (Case-Smith and Rogers, 2005).

When children are diagnosed with disabilities and special educational needs, and their participation in meaningful activity may be affected due to deficits in client factors and performance skills, the deficits in various prerequisites for the occupation of education need to be addressed. The role of occupational therapy within a school-based setting should therefore be focused on these client factors and performance skills in order to remediate or compensate for these and thus facilitate engagement in the occupation of education (American Occupational Therapy Association, 2008).

Learners diagnosed with learning disabilities need more specialised and intensive forms of support to reach their optimal functionality within an academic setting. One of the learning disabilities associated with poor function in the classroom is ADHD; this study focuses specifically on this population. The effects of deficits or barriers to learning in ADHD are further explored within this literature review.

2.3. ATTENTION DEFICIT HYPERACTIVITY DISORDER

2.3.1 Diagnosis of Attention Deficit Hyperactivity Disorder

Medical practitioners, such as psychiatrists, neurologists or paediatricians, diagnose ADHD using the criteria of the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM V)(American Pschyiatric Association, 2013). The American Academy of Pediatrics (AAP) recommends that in addition to the DSM-V criteria, a standardised rating scale should be used to confirm a diagnosis of ADHD (American Academy of Pediatrics (AAP), 2011).

Attention Deficit Hyperactivity Disorder is diagnosed according to DSM-V criteria, which states that learners must display frequent and continued behavioural tendencies of inappropriate inattention, hyperactivity and/or impulsivity that hinders their functioning or development for at least six months. Symptoms must be observed before the age of 12 years and be visible in two or more different settings (home, school or other activities). There must be concise evidence of symptoms affecting learners' academic or occupational functioning (American Pschyiatric Association, 2013).

Globally, ADHD occurs in approximately 5 to 10% of children in various cultures (Antshel, 2015; American Pschyiatric Association, 2013). According to Child and Adolescent Mental Health Services (CAMHS), it is estimated that ADHD is more prevalent in boys than girls, with a ratio of 2:1 (Barbaresi et al., 2007).

2.3.2. Intervention considerations for learners with Attention Deficit Hyperactivity Disorder

It has been reported that learning disabilities occur frequently in children with ADHD (DuPaul and Stoner, 2003; DuPaul et al., 2013). Interventions from health and educational professionals play a significant part in facilitating success in occupational performance of learners diagnosed with ADHD. There are various intervention approaches to consider, such as pharmacologic treatment, behaviour management and school-based services (Loe and Feldman, 2007).

Pharmacologic treatment is normally the first line of intervention for ADHD, with approximately 80% of children diagnosed with ADHD receiving medication (McClain and Burks, 2015). Thus, the majority of research in ADHD is focused on the pharmacological management. The most common medications prescribed for the pharmacological intervention of ADHD are psychostimulant medications, such as methylphenidate (Antshel, 2015). These medications have been shown to decrease impulsivity and inattention, the core symptoms of ADHD, however this has not been associated with a concomitant success in improving academic output (Loe and Feldman, 2007; Antshel, 2015). Concerns relating to the pharmacologic treatment of ADHD includes, side effects and low compliance (McClain and Burks, 2015; Daley et al., 2014). Additionally, it has been found that medicated learners diagnosed with ADHD continue to exhibit executive functioning difficulties (Safren, 2006) and some children do not respond to pharmacological intervention (O` Connell et al., 2006). It is therefore essential to consider all the available treatment options for learners diagnosed with ADHD to ensure their academic success. Various treatment options are available for learners diagnosed with ADHD, such as occupational therapy, psychotherapy and special education intervention. In 2001, the American Academy for Pediatrics (AAP) identified a gap in literature that provides sufficient evidence for the effectiveness of psycho-educational approach in ADHD treatment (American Academy of Pediatrics; Subcommittee on Attention-Deficit/Hyperactivity Disorder, 2001). A study conducted in 2005 illustrated that working memory of leaners diagnosed with ADHD can improve by using psycho-educational intervention strategies (Klingberg et al., 2005), while Papavasiliou et al. (2007) found this type of intervention to be effective for remediating visual perceptual skills in children diagnosed with ADHD.

2.3.3 Client factors and performance skills in Attention Deficit Hyperactivity Disorder affecting academic functioning

2.3.3.1 Inattention

Attention Deficit Hyperactivity Disorder has been found to be one of the most commonly occurring neurodevelopmental disorders that has a detrimental impact on academic performance (Hendrikse et al., 2015). The academic performance of learners diagnosed with ADHD is affected by careless mistakes made in their work due to difficulty in attending to detail during schoolwork and other activities. These learners also have trouble in sustaining attention during tasks in lessons or activities such as reading, and can often be distracted by external stimuli in the classroom (American Pschyiatric Association, 2013). For them it is challenging to follow instructions and to complete tasks and they are often disorganised and require structure to achieve success.

2.3.3.2 Hyperactivity and impulsivity

Not all learners diagnosed with ADHD will present with the hyperactivity subtype. For those who do, the associated behaviour affects their ability to maintain a seated position in the classroom - they may find it difficult to stay seated and prefer walking around in class. Children diagnosed with ADHD often wriggle with their hands or feet as well as move around in their chairs, demonstrating restless behaviour (American Pschyiatric Association, 2013). Learners diagnosed with ADHD may talk a lot and can possibly blurt out answers before a question is completed, they do not like waiting for their turn and often interrupt or intrude on others, which affects their ability to benefit from the traditional classroom teaching and research indicates they do not achieve their academic potential and receive lower grades than their peers. They are also likely to display higher rates of grade failure and higher school dropout (Martin, 2006; Loe and Feldman, 2007; Evans et al., 2014).

2.3.3.3 Visual Perceptual Deficits

The most prevalent academic challenges for young learners diagnosed with ADHD include reading, writing and calculations (Loe and Feldman, 2007). Learners diagnosed with ADHD often experience academic barriers to learning due to visual perceptual deficits, poor visual attention, impulsivity and other neuro-cognitive structural and functional deficits. Occupational therapists are aware of the importance of the development of adequate visual perception in order to achieve fluent reading, copying from the blackboard, spelling words, doing maths and executing other academic tasks within the classroom environment (Case-Smith and Rogers, 2005; Schneck, 2010b; Schneck, 2010a; Bazyk and Case-Smith, 2010).

Before constructing strategies for remediation of visual perceptual deficits, it is important to look at research that associates these deficits directly with children diagnosed with ADHD. This will be discussed and integrated in the next sections.

2.4 THE VISUAL SYSTEM AND VISUAL PERCEPTION

2.4.1 The Visual System

The visual system enables us to extract information from the environment though our eyes and interpret the information in the brain (Schneck, 2010b). It is estimated that 70% of sensory receptors in humans are assigned to vision and only 30% to other senses (Schneck, 2010b). The visual system therefore plays an important role in providing us with information that allows us to make decisions based on safety, execution of task, and facilitates participation in occupations (Schneck, 2010b).

Visual perception is defined as “the total process responsible for the reception (sensory functions) and cognition (specific mental functions) of visual stimuli” (Schneck, 2010b):373). The reception of visual stimuli occurs through the sensory system, this process is responsible for drawing information from the environment and re-arranging it in a meaningful manner (Schneck, 2010b; Schneck, 2010a). The visual-cognitive component allows for the organisation, structure and interpretation of the visual stimuli, therefore giving meaning to what is seen (Schneck, 2010b); both aspects are required for functional vision and allow the person to understand what they have seen. According to Schenck’s Model of Visual Processing, visual receptive and cognitive skills are classified as client factors (Schneck, 2010a) (Figure 2.1).

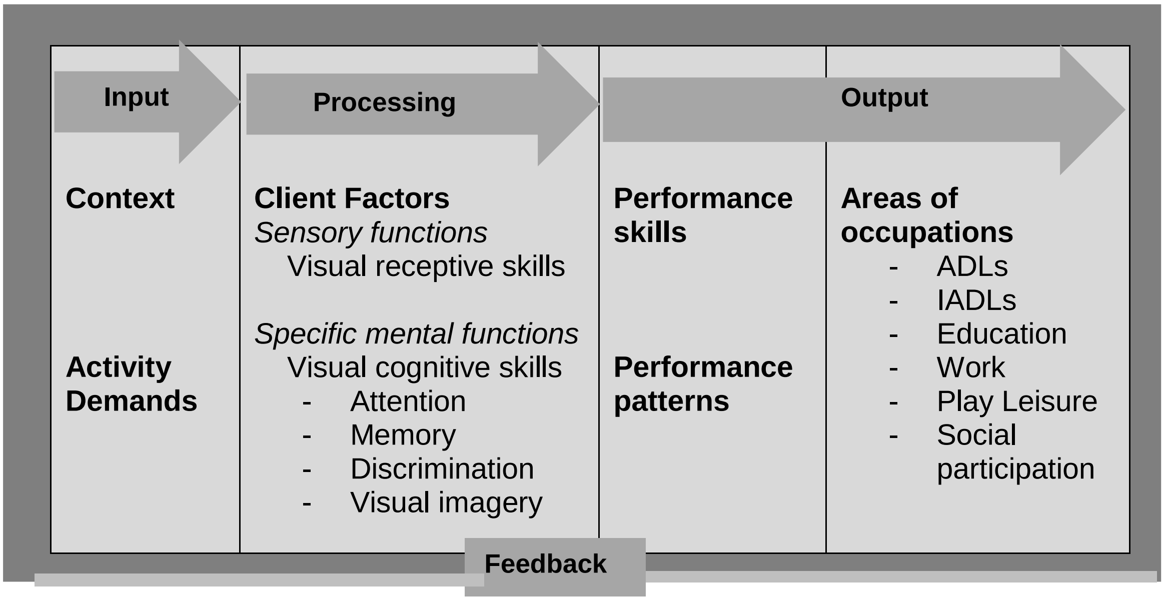

Figure 2.1: Visual Processing model Scheck (2010)(Schneck, 2010a):356)

This classification is supported by the OTPFIII in line with the ICF, with the receptive components of vision and visual efficiency (Warren, 1993) falling under the client factors related to sensory functions. Visual perception and visual-cognitive performance components are classified under specific mental functions (American Occupational Therapy Association, 2008).

2.4.2 Vision Receptive Skills

The foundation for all vision or visual receptive skills comprises vision (visual fields, visual acuity and refraction) and visual efficiency, which includes oculomotor function. It is thus important for an occupational therapist to ensure these primary visual functions are intact before commencing with visual perceptual assessment and treatment. A multidisciplinary approach is required, and an optometrist can assist in assessment and treatment of basic visual functions (Schneck, 2010a).

2.4.2.1 Vision

In order to see clearly, adequate visual acuity, refraction and complete vision in the visual fields is essential and is dependent on the structure and functioning of the eyes. The eye functions with light that is conducted through the lens to the retina, and light is then focused on images of the environment (Remington, 2012; Schneck, 2010b). The retina of the eye responds to spatial differences in the amount of light stimulation, which triggers electric impulses to the optic nerve. The optic nerve (cranial nerve II) sends visual sensory data to the brain for neurological processing (Schneck, 2010b).

2.4.2.2 Visual Efficiency

Visual efficiency is related to oculomotor control and other aspects, such as accommodation, and stereopsis for visual processing and perception (Vlok et al., 2011a; Schneck, 2010b). This visual function allows for the effective gathering of visual information and the processing of visual input (Schneck, 2010b; Scheiman, 2011). Various research studies have suggested that learners diagnosed with ADHD experience difficulty with this component of the visual system, particularly oculomotor control (George et al., 2005; Papavasiliou et al., 2007); this may sequentially have a negative impact on performance skills related to academic tasks such as reading, writing and mathematics (Schneck, 2010b). According to Scheiman (2011), visual efficiency includes visual receptive functions, which are dependent on oculomotor system to process visual information. Important aspects of the oculomotor system include various eye movements, such as fixations, visual tracking or pursuits and saccadic eye movements. Oculomotor functions are required for visual processing when participating in the occupation of reading, writing and copying. Each oculomotor function has a unique role to play in order to obtain information from the environment (Scheiman, 2011).

Visual fixation

All oculomotor functions are dependent on the ability to fixate on a stationary object (Schneck, 2010b). Visual fixation is a spatially stable gaze and directs visual attention, a fundamental cognitive aspect required before any visual learning can take place (Duchowski, 2017). Inadequate visual fixation may result in looking away from a task frequently, affecting task behaviour and learning in the classroom (Scheiman, 2011). An indication for dysfunction in visual fixation is reduced ability to control and direct gaze, resulting in a learner losing their place while reading (Schneck, 2010a).

Visual tracking

Visual tracking, or pursuits, enable a learner to stay focused on a moving object (Schneck, 2010b). Visual tracking (smooth pursuits) is a slower ocular movement that plays a role in reading and allows a child to follow each letter, word, sentence in a full line of text (Duchowski, 2017).

Saccadic eye movements

Saccadic eye movements are responsible for the fast movements in fixation from one part to other parts of the visual field (Schneck, 2010b). Scheiman and Rouse (2006) reported that children diagnosed with ADHD experience tasks that require saccadic eye movements as more challenging due to slower reaction times (Scheiman and Rouse, 2006). Reading requires a combination of short saccades and short fixation pauses. The initial requirement for successful reading is right forward saccades, which is also known as forward fixation; at the end of the line, large left forward saccades are needed to start new line (Scheiman and Rouse, 2006). Learners with saccadic dysfunction might also omit words while reading (Schneck, 2010a) and would therefore need to use an object or marker to keep their place while reading (Schneck, 2010a).

Considering the role that vision and visual efficiency play, they are essential considerations when deciding on intervention strategies for the treatment of visual processing and perceptual challenges (Vlok et al., 2011b; Schneck, 2010b).

2.4.3 Visual Cognitive Skills

Visual perception is dependent on visual information being transferred from the eyes, via the thalamus to the visual cortex located in the occipital lobe (Schneck, 2010b). Visual perceptual processing occurs in numerous parts of the brain and is reliant on the flow of visual information according to two-streams (Goodale and Milner, 1992).

The two-streams model of the neural processing, as described by Goodale and Milner (1992), presents two distinct visual systems (Goodale and Milner, 1992), with visual information exiting the occipital lobe, following two main streams – a ventral and dorsal stream (Schneck, 2010b). In the ventral stream, the visual object processing takes place in the inferior temporal lobe where impulses flow downwards.

Colour, form and size identification occurs in the inferior temporal lobe, and is required in order to identify objects and for pattern recognition. The parvocellular channel governs the ventral stream, and is imperative for exploration of shape and surface characteristics of objects. The dorsal stream, where visual spatial processing takes place, stretches from the primary visual cortex to the posterior parietal lobe; humans require visual spatial processing to enable them to locate objects and to determine the object's relationship in space. The dominant channel in the dorsal stream is the magnocellular channel, which plays a role in motion, depth detection, stereoscopic vision and interpretation of spatial organisation. The development and maturation of visual perceptual skills are reliant on this structure and intact function of the visual system (Schneck, 2010b).

In order to assess visual processing and visual cognitive function, various visual perceptual components, or client factors, that can be observed and measured have been identified and described. These client factors, or visual perception components, include: visual attention, visual memory, visual discrimination (form constancy, visual closure, figure ground and spatial perception), as well as visual imagery (Schneck, 2010a). Dysfunction in these visual perception client factors will also be considered in relation to ADHD. Further detail relating to visual perceptual dysfunction is discussed in Chapter 3 to support the results of the record review, which formed Phase 1 of this study.

2.4.3.1 Visual attention

Visual attention is a process where the eye selects visual information and transmits information to the primary visual cortex for processing. Voluntary eye movements are the basis for optimal functioning of visual attention. Visual attention has four components: alertness, selective attention, sustained attention, visual vigilance, divided or shared attention (Schneck, 2010b).

Visual attention is a core aspect of visual perception and impacts on all visual perceptual skills if deficits occur. Poor visual attention can result in over attentiveness or under attentiveness, both of which can be dysfunctional. Learners who are over attentive can easily be distracted, present with poor visual memory due to a short attention span and experience an overload of irrelevant information; under attentive learners, find it problematic to orientate to the visual stimuli, get tired quickly, have poor sustained attention and habituate to visual stimulus. Additional dysfunction includes difficulty in extracting important information from a stimulus, and therefore an inability to isolate significant visual input. Learners with visual attentional problems also find it difficult to focus on two different stimuli at the same time (Schneck, 2010a).

This aspect of visual perception is specifically challenging for learners diagnosed with ADHD. DeShazo et al. (2001) researched selective visual attention and sustained visual attention performance of 30, 10 years old boys with and without ADHD. Their results concluded that while the boys diagnosed with ADHD performed as well as their non-ADHD peers on selective attention tasks, they had significantly weaker results in the sustained attention tasks (DeShazo et al., 2001). A more recent publication by McAvinue et al (2015) supported these results. They established that 25 children diagnosed with ADHD had dysfunctional sustained attention and slower visual processing speed than a typical sample without ADHD (McAvinue et al., 2015). Implications of these findings should therefore be taken into consideration when planning intervention for children with ADHD.

2.4.3.2 Visual Memory

Visual memory is the integration of visual information and prior life experiences and consists of long-and short-term memory. Long-term visual memory is the perpetual storehouse of visual information and has a large capacity. Short-term visual memory is the ability to recall insignificant bits of information for approximately 30 seconds (Schneck, 2010b). Visual memory is an essential aspect in the learning process and is required for academic skills such as spelling, writing letters and words, punctuation and grammar (Schneck, 2010a). An additional importance of visual memory is retaining information, such as study material, and the ability to recall the information for examinations (Schneck, 2010a).

Dysfunction of visual memory can create extensive educational difficulties for a learner and that will have major negative implications on academic achievement in terms of poor handwriting capabilities due to not being able to retain or recall letter formation. Letter reversal might also occur to due to visual memory deficits (Schneck, 2010a) and difficulty in reading, spelling, writing, constructing sentences, grammar and punctuation may also transpire (Todd, 1999). McAvinue et al. (2015)

did not find this aspect of visual perception to be more dysfunctional in children with ADHD than other learning disabilities. In contrast Papavasiliou et al. (2007) found that learners diagnosed with ADHD are more predisposed to experiencing challenges with visual memory. This might impact on their occupational performance in academic activities of reading, spelling and mathematics.

2.4.33 Visual Discrimination

It is important to note that object (form) vision comes from the ventral stream and spatial vision from the dorsal stream. As both these aspects play and important role in visual discriminative tasks, it is imperative to comprehend the effect of the different neural pathways. Object (form) perception and processing is responsible for the visual identification of objects by colour, texture, shape and size, and can be categorised by form constancy, visual closure and figure ground recognition (Schneck, 2010b).

Visual discrimination is a foundation of visual perceptual skills and is inter-correlated with visual memory, form constancy, visual closure, figure ground and spatial perception (Martin, 2006; Schneck, 2010a). Visual discrimination is an integrated skill that requires recognition, finding similarities and categorising the features of visual stimuli. Recognition is the skill that allows a person to observe the most important characteristics of a stimulus and communicate them to memory (Schneck, 2010a; Schneck, 2010b). In addition, matching is the ability to observe similarities in visual stimuli. Categorisation is to determine the value or classification by which similarities or differences can be placed and this requires long-term memory (Schneck, 2010b).

Papavasiliou et al. (2007) found that learners diagnosed with ADHD have a greater difficulty in completing activities that require visual discrimination than typical peers. Challenges in visual discrimination skills might result in poor letter formation, impaired decoding ability when reading or comprehension with reading. Reversal of letters or numbers after the age of seven years may indicate poor visual discrimination (Schneck, 2010a).

Form constancy

Form constancy is the skill to identify forms and objects within the same or different environments, positions and shapes and enables a person to mature constancy and consistently in the visual world. Additionally, it contributes to reasoning skills and assists a person to anticipate the size, shape and orientation of an object even though visual stimuli might not be the same. Functionally, form constancy enables a learner to identify a letter, for example “A,” in various formats such as typed or written, upper or lower case, print or cursive. Challenges with copying diverse type of print or handwriting might occur if a learner has form constancy deficits. Learners might also struggle to identify errors in their own handwriting and to correct them (Schneck, 2010a). There is limited evidence that confirms that learners diagnosed with ADHD have difficulties with perceptual constancy.

Visual Closure

Visual closure is the skill to recognise forms or objects from partial presentations. This ability allows us to identify objects, shapes and forms quickly and cognitively. Papavailiou (2007) confirmed that there is a higher prevalence of visual closure challenges in learners diagnosed with ADHD. The functional implication of deficits in visual closure is that a person would not be able to read a sign if letters were partially covered with leaves (Schneck, 2010b).

Figure Ground

Figure ground allows objects that are in the background and foreground to be distinguished. It enables the separation of essential information from distracting adjacent information and for attention to be paid to one element of a visual object in relation to the visual field (Schneck, 2005).

A learner with visual figure ground difficulties can over attend to certain visual information and not see the big picture, or may oversee detail during classroom activities. Reading might also be a challenge for a learner with figure ground difficulties, as attending to one word on a printed page and the ability to block out the other words around it may be impaired (Schneck, 2010b). Learners who struggle with figure ground may struggle with visual search strategies and finding objects in a cluttered environment (Schneck, 2010a).

Spatial perception

Spatial perception can be differentiated into spatial relations and position in space (Schneck, 2010b). Position in space is the ability to identify objects in relation to oneself or other objects (Schneck, 2010a; Schneck, 2010b). Spatial perception is essential in comprehending directional language such as in, out, up, down, front, back, left and right (Schneck, 2010a). It therefore allows a person to distinguish letters from one another and sequences of words in a sentence (Schneck, 2010b).

Learners with visual spatial dysfunction have challenges with organisation and execution of their motor action in relation to items around them. Letter reversals and reversal order may occur after nine years of age, and they might have difficulty with sequencing of letters or numbers, for example, they might read, “was” as “saw.” Spacing of letters or numbers is also challenging during writing activities and adapting to keep within the margins. Learners might struggle to read or write from left to right as directionality is a challenge for them (Schneck, 2010a).

Visual Imagery

Visual imagery, or visualisation, is an integral aspect of the visual cognition component. Visual imagery can be described as creating a mental picture of an object, people or ideas even though it is not present. Developmentally, multisensory components play a role in visual imagery and children will first remember images that have an auditory or olfactory component as well. Visual imagery is an important aspect for learning and is the foundation for reading comprehension and spelling (Schneck, 2010b).

Schenck’s Model of Visual Processing in Figure 2.1 indicates the relationship between visual processing and output or performance. The visual perception client factors which comprise visual processing, influence performance skills and performance patterns and in turn participation in occupation, particularly in education. Occupational therapists routinely address these client factors due to the effect deficits have in creating barriers in academic achievement.

2.4.3 Visual Motor Integration (VMI)

Visual Motor Integration refers to the integration of visual skills, visual perceptual skills and motor skills (Exber, 2005). Visual perception and visual-motor integration is viewed as two separate functions due to the motor component that might impact on the outcome (Parush et al., 1998). Researchers found that there is a relationship between VMI and the Visual Memory as well as Visual-Spatial Relationships subtests of the TVPS (O'Brien et al., 1988; Parush et al., 1998).

Visual Motor Integration is required for the occupational performance component of handwriting. Integration of visual images such as letters or shapes is required to make the appropriate motor responses for handwriting to occur (Schneck, 2005). Germano et al. (2013) found that learners diagnosed with ADHD perform more poorly on VMI assessment than typical peers, where inattention is a contributing factor to their underperformance. Racine et al. (2008) confirmed that learners diagnosed with ADHD often present with illegible handwriting, poor handwriting speed and execution is also atypical when compared to peers.

2.5 OCCUPATIONAL THERAPY FOR VISUAL PERCEPTUAL FUNCTION

The OTPFIII recommends a move to occupation-based therapy in occupational therapy, using a top-down approach and intervention based on occupational performance. Weinstock-Zlotnick and Hinojosa (2004) dispute the use of this approach alone and indicate there are reasons to continue using a bottom-up approach, where the assessment and intervention of client factors allows focus on component deficits, such as visual perception (Weinstock-Zlotnick and Hinojosa, 2004). This is supported by the occupational therapy literature, which points out that the remediation of visual perceptual problems includes three main frames of reference. The first is sensory integration, which focuses on the adaptive response; the second is the neuro-developmental frame of reference used to encourage normal patterns of movement; the third, the developmental frame of reference using a hierarchical model of visual perceptual to facilitate visual perceptual abilities, as indicated by Schenck (Vlok et al., 2011a; Schneck, 2010a). These frames of reference support the remediation of foundational client factors first to improve perceptual skills and functioning utilising a bottom-up approach (Schneck, 2010a;

Warren, 1993). It is suggested therefore that evaluation and treatment strategies should address the specific deficits identified within the visual system in order to achieve improvement in occupational performance in academic and other activities (Schneck, 2010a; Warren, 1993).

However, even when the bottom-up approach is used for assessment, occupational performance outcomes are essential to confirm the effectiveness of the intervention to establish evidence and to contribute scientifically to the profession (Case-Smith, 2015). Assessment of academic outcomes related to visual perception will also contribute to treatment planning when using the Dynamic System Model of Visual Perception (DSTMVP). Academic outcomes will assist the learner with knowledge and experience and contribute to visual perception (Coté, 2011). Thus, an assessment of academic outcomes will be used in the study.

2.5.1 Assessment of visual perception and academic outcomes

Assessment of visual perceptual function is used as a baseline for intervention planning and provides information on the effectiveness of the therapy progress. Norm reference tests are generally used by occupational therapists for the assessment of visual perceptual function (Richardson, 2010).

Various standardised assessment tools are available and those frequently used in practice in South Africa are Test of Visual Perceptual Skills 3 (TVPS 3)(Martin, 2006), Developmental Test of Visual Perception 3 (DTVP 3)(Hammill et al., 2014), Componential Assessment of Visual Perception (CAVP) (Reid and Jutai, 1994), Motor-free Visual Perception Test (MVPT-4) (Colarusso and Hammill, 2015), Wide Range Assessment of Visual Motor Abilities (WRAVMA) (Adams and Sheslow, 1995) and the Beery-Buktenica Developmental Test of Visual-Motor Integration 6th ed (VMI) (Beery et al., 2010). Only the Test of Visual Perceptual Skills 3rd edition (TVPS-3) and the Beery-Buktenica Developmental Test of Visual-Motor Integration tests (Beery VMI), which were used in this study, will be discussed. Validity and reliability, which indicate test precision, consistency and accuracy, need to be taken into account when selecting tests for research or clinical purposes (Salvia et al., 2007; Martin, 2006) and both these tests have been found to be valid for use with children attending a school for learners with special needs in an urban area in Gauteng, South Africa (Harris, 2017).

Results of the standardized test (TVPS-3, Beery VMI) can be interpreted by considering the z-score. A below average result is evident if the standard deviation is below the mean. An average result is obtained if the standard deviation is above the mean. Other scores such as scaled scores, standard scores or percentiles can also be considered (Harris, 2017).

2.5.1.1 Test of Visual Perceptual Skills

Development and description of the TVPS

The first standardised tests of visual perceptual skills were developed in the 1970s and 1980s (Colarusso and Hammill, 1972),(Colarusso and Hammill, 1996; Gardner, 1982). The first publication of the TVPS was in 1982 and a revised version, TVPS-R, was published in 1996 (Gardner, 1982; Gardner, 1996; Gardner, 1986). The TVPS-3, which was developed by Nancy Martin and published in 2006, and the TVPS-R have slight differences. The TVPS-3, which is a combination of the TVPS-R and TVPS-UL-R and covers the ages of the previous editions, is a standardised assessment tool that can determine visual perceptual assets and challenges of learners aged 4 to 18 years. The format of the test is multiple-choice questions, with 112 black and white line drawings as stimuli. The structure of the TVPS changed in the third edition; all subtests have the same amount of test items (16) and two example items instead of one. The subtests of the TVPS R and TVPS-3 are similar and consist of eight visual perceptual areas, including Visual Discrimination, Visual Memory, Spatial Relationships, Form Constancy, Sequential Memory, Figure Ground and Visual Closure (Martin, 2006). A new additional scoring component of composite scores was added to the TVPS-3 version to enhance interpretation (Martin, 2006).

Scoring and standardisation of the TVPS-3

A raw score can be obtained from each sub-test, and then converted to scaled scores, percentile ranks or age-equivalent scores. The overall performance score is described as a standard score or percentile. Responses can be made vocally or by pointing to the correct answer. The motor free (motor action not assessed during this assessment) aspect of the test is an advantage because it provides a greater accurate insight of visual perceptual aspects and eliminates motor, advanced language abilities, neurological or hearing delays that learners might experience. An additional advantage is that it takes only approximately 30 to 40 minutes to conduct the test (Martin, 2006).

The test was standardised by 2008, assessing students in 38 states of the United States of America (USA). Numerous reliability studies have been conducted on the TVPS-3 assessment, and it is considered as having a good reliability. The overall test achieved 0.96 coefficient alpha for split-half reliability, indicating good internal consistency. Reliability is strengthened by the high level of uniformity the test offers and the consistency in measurement from one subtest to the next. The test-retest reliability of the TVPS-3 test, as a whole, is 0.97 and ranges from 0.34 to 0.81 for individual subtests. Inter-rater reliability of the test is good for all age bands (Cl95%-90%). Reliable test results will therefore be obtained from various examiners (Martin, 2006). Brown and Hockey support the findings of the Martin study and confirm the reliability properties of the TVPS-3 (Brown and Hockey, 2013; Martin, 2006). Research conducted on the TVPS-3 to determine the external validity of the visual memory subtest indicated that this subtest and a related activity demanding visual memory was low to average with a significant and moderate correlation (r=0.411)(Coté, 2011). The criterion related validity was moderately strong (0.67) for the visual supplement of the Developmental Test of Visual-Motor Integration (VMI-5)(Beery and Beery, 2004; Martin, 2006). There is a gap in the research on the validity and reliability of the TVPS-3 for the South African population because the available research is limited(Harris, 2017; Richmond and Holland, 2011). The TVPS-3 had low sensitivity (below 0.80), high specificity for spatial relations (above 0.80), and good reliability in terms of internal consistency (Cronbach`s alpha coefficients of ≥0.70) for a sample of learners in Gauteng. Learners from a mainstream population in Gauteng acquired lower mean scale scores for form constancy and visual discrimination in comparison to the US sample, while mainstream and LSEN learners obtained higher mean scale scores for spatial relations compared to the US population (Harris, 2017).

Research conducted on the TVPS-3 indicated there were non-significant differences between the scores of medicated learners diagnosed with ADHD and non-medicated learners(Martin, 2006). The TVPS-4 was only published in 2017 after the completion of the data collection for this study; the TVPS-3 was therefore considered an adequate tool to use to provide a high level of confidence in the test results.

2.5.1.2 Beery-Buktenica Developmental Test of Visual-Motor Integration 6th ed

The Developmental Test of Visual-Motor Integration – 6th Edition (Beery VMI-6), published in 2010, is the most recent version used by therapists. The first Beery VMI edition was published in 1967, after Dr. Keith Beery, a clinical psychologist, and Norman Buktencia developed the test. They designed four of the geometrical forms included in the test and Natasha Beery assisted with the test development; it has been standardised six times between 1964 and 2010 (Beery et al., 2010).

The test is used is to assess the integration of motor action and visual perceptual functioning. The latest edition of the Beery VMI added new standardised norms for ages 2 years to 100 years, and includes additional developmental stepping-stones from birth to the age of 6 years. This standardised test has raw scores that can be translated into age equivalent scores, scaled scores and percentiles (Beery et al., 2010).

Visual-motor integration is described as the quality of integration of visual perception and fine motor abilities (Beery et al., 2010). Visual receptive functions, visual cognitive functions, fine motor skills and the integration of visual, motor and cognitive processes are required to achieve visual-motor integration (Dankert et al., 2003; Schneck, 2010b). Visual motor integration has been found to be associated with handwriting development and academic performance in reading and mathematics in younger learners (Sortor and Kult, 2003; Dankert et al., 2003; Cornhill and Case-Smith, 1996; Beery et al., 2010).

Participants are required to copy different geometrical shapes during the Beery VMI test, which also includes two supplemental standardised tests for visual perception and motor coordination. The visual perception test is a motor free test, where participants are required to identify the exact match of geometrical form stimuli. Participants are required to trace stimulus forms with a pencil during the motor coordination subtest (Beery et al., 2010).

An advantage of the Beery VMI-6 test is that it is language free, and the black and white geometrical shapes assist in limiting possible cultural barriers (Beery et al., 2010). Furthermore, the test presents with good internal consistency, inter-scorer reliability, content validity, concurrent validity, and construct validity. Rigorous statistical analyses were used to determine the validity and reliability using a sample size of 13 000 children in the USA. Construct validity was determined using the Rash Measurement Model of the 5th Edition (VMI-5) (Beery and Beery, 2004) and the content sampling (Beery et al., 2010). Coefficient alpha and Spearman-Brown corrected results were utilised in calculating the internal consistency (median.84), therefore indicating high content reliability and person reliability. The total group item separation was 1.00 and the total for person separation was 0.96, confirming the high levels of content reliability. From a validity perspective, the Beery VMi-6 also displayed strong content validity, concurrent validity, and predictive validity (Beery et al., 2010). All validity measures achieved coefficients of between .80 and .95.

A study conducted in 2017 indicated good internal consistency (0.7), significant discriminative validity and reliability (coefficients between 0.8 and 0.9) of the VMI-6 on a South African sample (Harris, 2017). Similar results were found by Coallier and Rouleau for the Canadian preschool population, although significant gender differences were established (girls obtained higher mean scores than boys) and therefore a recommendation for further research was made (Coallier and Rouleou, 2014).

2.5.1.3 Assessment of Academic Outcomes Related to Visual Perception

The Human Sciences Research Council (HSRC) developed one-minute reading, addition and subtraction tests. These tests were standardised for the South African population for Afrikaans and English speaking learners in the age band from 6 years to 16 years. There is no literature or research available on this test, but it is the only bilingual reading and mathematical test specifically developed by the HSRC for learners in South Africa, and although a validity for the test has been reported, no values are available to justify this and the reliability. The purpose of the test development was for use as criterion tests for determining validity; no additional information is available (Human Sciences Research Council, 1996).

2.5.2 Intervention of Visual Perception

In order to provide intervention for visual perceptual deficits, it is important to take the conceptual foundation for the treatment of visual perception, frames of reference as well as models into account, which support intervention.

2.5.2.1 Conceptual foundation for the treatment of visual perceptual dysfunction

A conceptual foundation with underlying assumptions is required for the effective and scientific treatment of occupational dysfunction. Treatment of visual perceptual deficits has traditionally been divided in two categories, remedial and adaptive (Neistadt, 1994). Numerous factors are taken into account to determine which approach should be utilised. Remedial therapy utilises the bottom-up approach, with the goal of addressing underlying impairments, and may be used in conjunction with a development framework. Top-down therapy is used with the adaptive approach, usually for populations where restoration is unlikely (Zoltan and Siev, 2007; Neistadt, 1994; Trombly, 1993). Thus remedial therapy is commonly used for the intervention of visual perceptual dysfunction in learners diagnosed with ADHD (Zoltan and Siev, 2007; Trombly, 1993).

Remedial therapy is based on the assumed plasticity of the brain and that function can be improved by establishing connections and forming new synapses. Remedial therapy targets specific deficits in client factors and uses repetition to improve visual perceptual function through the formation of new neural connections (Zoltan and Siev, 2007). In addition, a building block approach is taken based on the hierarchical elements in visual perception that facilitate the performance in various areas.

Thus, visual processing models and frameworks, as well as various theories, are further reviewed as a conceptual foundation to support the treatment of visual perceptual dysfunction in conjunction with the hierarchical framework.

2.5.2.2 Visual perception and visual processing models and frameworks

Extensive literature on visual information processing models explains how learning visual perception is facilitated. These theoretical concepts that guide the development and change in visual perception, are reductionist and divide visual perception into categories and levels as described above (Martin, 2006; Chase, 2014). Models of visual processing assume that information processing includes the reception of information (input), the organisation and assimilation of information (processing) and output, and form the basis for the Visual Processing Model described by Schenck, illustrated with intervention approaches in Figure 2.2 (Schneck, 2010b; Abreu and Toglia, 1987).

Visual Processing Model

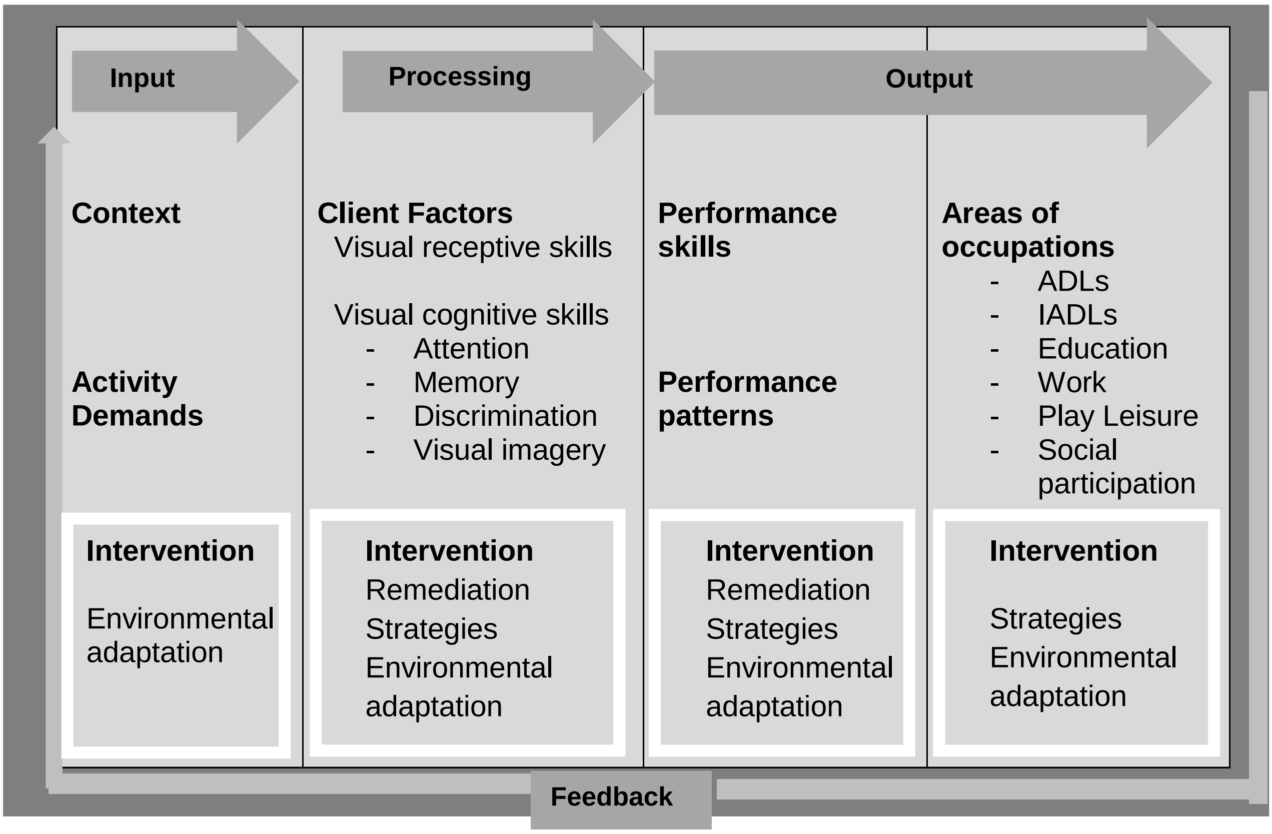

Figure 2.2: Visual Processing Model with Intervention (Schneck, 2010a):356).

Schneck (2010a) proposes that the first step of information processing is recognising and attending to sensory input, after which input is compared to previously stored information. This information is then transformed into cognitive representation and assigned meaning or acted upon and observed as output. Visual perceptual learning will therefore be determined by the quality of output provided. Feedback to the visual system is provided by this output, providing reinforcement so that learning occurs. Theoretically, visual information processing can be viewed on a continuum from simple to complex. Simple visual processing requires little effort on an analytical level and involves the recognition of objects, colours and shapes; it is the ability to make gross discrimination of size, position and direction. Complex visual processing requires concentration, effort and analytical thinking (Schneck, 2010a), therefore learners diagnosed with ADHD will experience greater difficulty with complex visual processing and require more support.

Intervention used within schools to remediate visual perceptual deficits should consider all the points described above (Schneck, 2010b) and, as can be seen in Figure 2.3. This intervention based on the Visual Processing Model should include remediation, using different strategies to present the visual information to the learner as well as environmental adaptation.

Framework of Hierarchical Development of Visual Perception

The Framework of Hierarchical Development of Visual Perception, is based on the developmental frame of reference and places strong emphasis on the importance of considering developmental processes, which occur in a sequential fashion with one process developing to allow the development of more complex processes (Zoltan and Siev, 2007). The developmental frame of reference supports mastery of skills (Schneck, 2010b; Schneck, 2010a) in a hierarchical fashion, providing reinforcement that enables a child to generalise the skill to other tasks which then improves occupational performance and facilitates successful participation in occupations (Schneck, 2010a). The use of a hierarchical model also assumes that certain skills or client factors are essential for the development of higher-level skills. These assumptions underlie the tests that are used to assess these constructs and explain the difficulty a child experiences.

This theoretical basis makes the Framework of Hierarchical Development of Visual Perception an appropriate point of reference on which to base intervention for visual perception (Schneck, 2010a; Schneck, 2010b; Warren, 1993). Although this framework (Figure 2.3) was constructed to guide assessment and intervention strategies for adults with acquired brain injury (Schneck, 2010a; Warren, 1993), it has proved to be a useful model to use for children with visual-perceptual deficits (Schneck, 2010a; Schneck, 2010b) as it supports the sequential nature of the developmental process of visual perception (Schneck, 2010a).

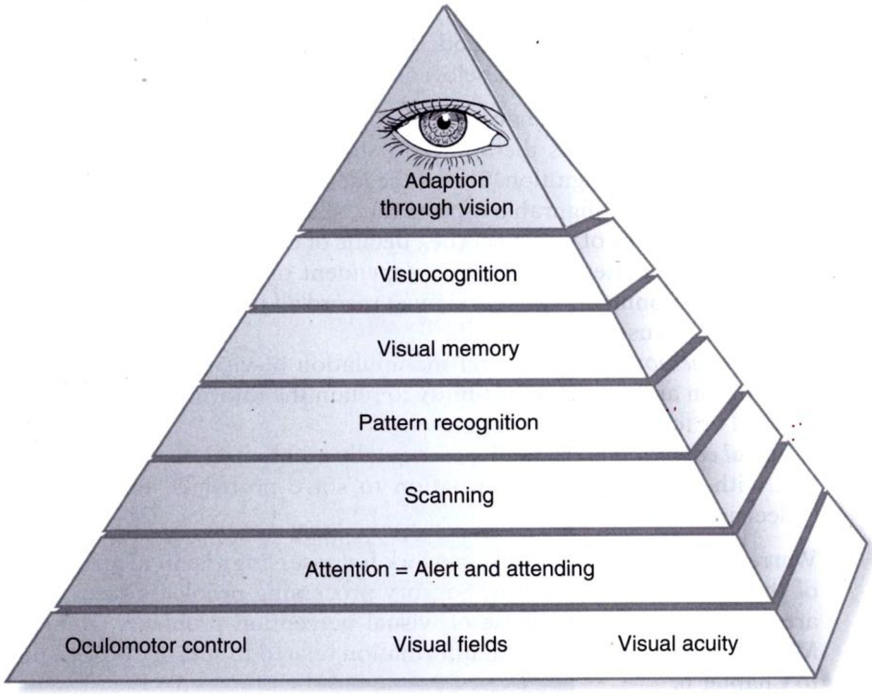

Figure 2.3: Framework of Hierarchical Development of Visual-Perception (Warren, 1993):43)

Based on this hierarchical framework, remediation of visual perception occurs through perceptual learning by extracting information for different categories in the order they are listed, and by organising the information and practicing the skills involved to use it in a meaningful manner (Schneck, 2010a).

Dynamic System Theory Model of Visual Perception

Although visual perception is conventionally observed from a reductionist point of view, and although this view might be appropriate for assessment purposes where subcategories are examined in order to establish level of functioning, it may not be the best construct to support intervention (Goldstand et al., 2005). Coté (2015) proposes Dynamic Systems Theory Model for Visual Perception (DSTMVP) as an alternative perspective on the intervention of visual perceptual development, arguing that when visual perception client factors are treated in isolation there is minimal carry-over to academic performance (Coté, 2015).

The Dynamic Systems Theory Model of Visual Perception is best described as “the experience of vision is understood as a result of the interaction between the environmental light signals on the retina and the various processes in the brain” (Coté, 2015):159). Key assumptions of the dynamic systems theory are that active and complex interaction of components are responsible for visual perception including other components that might impact on visual perceptual skills, such as tactile perception, movement, language, motivation, attention and knowledge. Perception is considered as the collaboration between the visual system and the unique elements of the individual, as depicted in Figure 2.4 (Lauwereyns, 2012).

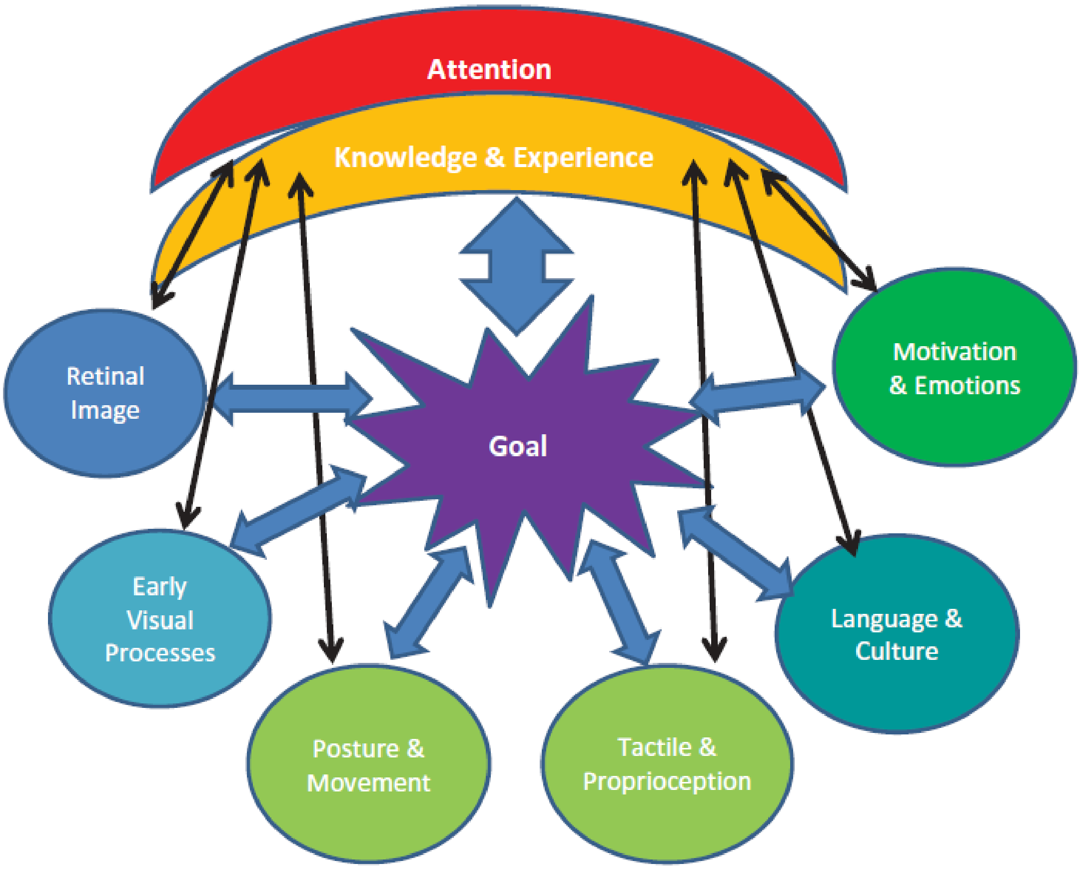

Figure 2.4 Dynamic System Theory Model of Visual Perception (Coté 2015:160)

In this model, components interact with each other and have an impact on one other. The foundation of this model is goal directed rather than skill directed, and assumes that each individual is unique based on their sensory experiences (Aldrich, 2008; Coté, 2015). The goal which forms the centre of the model should be a purposeful visual or visual perceptual activity, that is intentional and self-directed (Lazzarini, 2004). Goal setting should not be systematic or structured, but an interactive and powerful process that facilitates action. There are various levels of goals from immediate discrete goals, such as looking at a particular feature to get information, to the larger goals, such as searching for a piece to complete a puzzle. The goal should serve to facilitate the action (Coté, 2015).

Two umbrella concepts in the model are attention and knowledge, which are essential for visual perception. Attention guides the eyes to obtain detailed information (Gilbert and Li, 2013; Coté, 2015; Noë, 2004). The other function of attention is to select and understand information that is required for the activity (Gilbert and Li, 2013; Coté, 2015). Knowledge is also linked to attention, and allows cognitive processes to encrypt new knowledge; thereafter it notifies attention as to what is significant for goal attainment. Attention and knowledge are central to selecting and constructing elements required in attaining the goal. The interaction is however bi-directional and as the goal is realised, knowledge is adapted (Coté, 2015).

Should the visual image be too complex and vision alone is not sufficient, then attention and knowledge will recruit other systems to assist in achieving the goal (Coté, 2015). These systems, represented around the goal in the model, firstly include the retinal image. Context and experience can alter the functioning of the retina and it becomes accustomed to relevant features (Gilbert and Li, 2013; Lauwereyns, 2012). For example, when a child is doing a math worksheet, retinal cells will fire for the horizontal line under numbers; attention will therefore be faster and more effective (Lauwereyns, 2012).

The second system is linked to early visual processes, which occur closest to the retinal input and filter incoming information (Gilbert and Li, 2013; Lauwereyns, 2012). The lateral geniculate nucleus can enhance or decrease the input as visual perception becomes conscious, based on feedback from the visual system (Enns, 2004). The model assumes that visual perceptual input does not follow a one directional neural pathway but is dynamic and interactive, with input changing based on experience and what is relevant to the individual (Coté, 2015; Gilbert and Li, 2013; Lauwereyns, 2012).

Posture and movement and tactile and proprioception sensation form third and fourth systems associated with the achieving the goal in this model. Posture and eyes, head and body movement are required for adequate visual perceptual skills as both allow vision and visual input to occur on various levels. Movement in space is required to develop visual spatial capabilities, while posture is required to maintain a stable visual field, visual gaze and visual perception. From early childhood vision and touch collaborate when learning about objects (Coté, 2015). Vision and touch as exploration, or haptic perception, are fundamental in developing a sense of a spatial knowledge base (Coté, 2015; Noë, 2004).

Both language and culture also play an important role in vision and visual perception and form the fifth system associated with goal attainment (Coté, 2015). Language is used to direct attention and code and decode images in visual memory (Dessalegn and Landau, 2013). Research has reported on cultural differences that have an impact on visual perception, with some cultures focusing on context and others on discrete detail during visual perceptual tasks (Kitayama et al., 2003)

Motivation and emotion are the final system considered in the model, with motivation and emotions playing a role in visual attention and therefore impacting on visual perception (Coté, 2015). Motivation is known as a fundamental element in reaching therapeutic goals and positive emotions have been found to result in less distracted behaviour (Coté, 2015; Case- Smith, 2015a).

2.5.2.3 Theories related to visual perception and visual processing Learning Theories

Learning theories are fundamental for occupational therapy intervention and incorporate both social cognitive learning and behavioural theories, which form the basis of facilitating participation in occupational performance (Case- Smith, 2015a). Learning theories are theoretical frameworks that explain the process of information processing and retention during the learning process. Perceptual learning differs from cognitive and motor learning due to the presenting stimulus and task specificity. Understanding factors that determine perceptual learning is extremely important for planning successful intervention approaches. Perceptual learning is significant in highlighting neural plasticity in the perceptual system (Lu et al., 2010).

Behavioural Theories

Skinner (1953), a well-known behavioural theorist, proposed that individuals react to environmental responses and they will repeat behaviour that produced a positive response. Therefore, reinforcement that provides a positive or negative experience will guide future behaviour (Case- Smith, 2015a). Consequently, it is essential for learners to have a positive experience while engaging in intervention or remediation of visual perceptual skills. The therapist can shape the experience to achieve this by guiding the learner and giving positive reinforcement and feedback. Skinner reported in 1976 that positive reinforcement is usually associated with a pleasurable experience, which supports learning and behaviour and creates new behaviour (Skinner, 1976). Positive reinforcement impacts on motivation levels and assists learners to achieve their therapeutic goals (Case-Smith and Rogers, 2005).

Social cognitive theories

Bandura (1977) proposed a theory that children are able to observe behaviour of others and learn from that behaviour. This theory contains two significant concepts, acquisition and performance. During the acquisition phase, children observe the behaviour of others and decide what the outcome of that behaviour is; it is then stored in memory for later use. Performance is the result of acquisition when a child decides to apply the observed behaviour in a specific situation. Acquisition of performance theory is important when remediating visual perceptual skills. The therapist must provide the learner with instructions and examples when presented with a new activity, thereby the learner can observe the behaviour and store in memory for later use. Bandura also proposed that the child’s perception of their own abilities also impacts on their performance (Bandura, 1989; Bandura, 1982; Bandura, 1977). This factor will also play a role in the motivation and emotion aspect of DSTMVP(Coté, 2015).

Vygotsky (1978) agreed there is value in learning within a social context. He viewed cognitive development as the internalisation of concepts and relationships through social interaction with individuals who are more cognitively competent. The therapist’s role in intervention is therefore vital in contributing to problem solving, and through language, facilitate the internalisation of the visual perceptual process. Vygotsky`s theory of instruction and environment was a precursor to dynamic system models that impact on learning in visual perception (Vygotsky, 1978). This theory support the language and culture system in the DSTMVP as well the knowledge and experience required (Coté, 2015)

2.5.2.4 Application of the models, frameworks and theories associated with visual perception and visual processing in occupational therapy

All the models, frameworks and theories described above support the ontological assumption of occupational therapy that humans are interconnected with their ever-changing environment and occupations and thereby transformed by their actions and environments (Hooper and Wood, 2014). They all support intervention, which will facilitate participation and engagement in occupations, remediation of client factors and performance skills as well as modifications in the presentation of information to accommodate learning (Smith Roley et al., 2008) .

Change in visual perceptual skills will occur when working on various interconnected components engaged in a visual activity to direct the visual system to different solutions. Treatment should include other modalities to assist the child in self-directed attention to specific aspects that have not been previously addressed. The Dynamic Systems Theory Model of Visual Perception can be used in accordance with an occupation-based model to achieve the goal of directed self-initiated behaviour in a specific context (Coté, 2015). This coincides with the intervention strategies and adaptation of the environment suggested in the Visual processing Model, which recommends various ways of achieving visual input to ensure that successful processing occurs and successful outputs are obtained (Schneck, 2010a).

Accordingly, it is essential to explore literature in order to establish how visual processing can be facilitated for learners with barriers to learning, specifically by the use of technology, which is the focus of this study.

2.6 USE OF TECHNOLOGY IN TREATING VISUAL PERCEPTION IN A SCHOOL SETTING

2.6.1 Technology in the education context in South Africa

Political change in South Africa was one of the main contributing factors in developing a new curriculum for the Department of Basic Education, and the education system has changed several times over the past years. The initial changes in the curriculum were made in 1997 (Jansen, 1998). In 2005, the outcomes-based education (OBE) curriculum was implemented, with the focus on outcomes or goals for each educational activity. The purpose of the OBE curriculum was to transform, Africanise the education system and promote democracy (Msila, 2007). The OBE curriculum presented with some challenges, therefore the new National Curriculum Statement for Gr R-12 was launched in 2012 and known as the Curriculum and Assessment Policy Statement (CAPS), This policy included the use of technology in the classroom and is currently still in use.

The education system is using technology more in the classroom and learners are becoming accustomed to it. Teachers use interactive whiteboards, visualisers, iPads and tablets as teaching and learning tools to facilitate education. Learners are thus more interconnected with technology within their education occupation than before. It is important take these factors into account when developing interventions for children with special education needs, as computers have also become a common therapeutic medium in occupational therapy over the last two decades (Ross, 1992; Schoonover and Argabrite Grove, 2015; Schneck, 2010b).

2.6.2 Advantages of incorporating technology in occupational therapy intervention

Technology is dynamic and rapidly evolving, shaping thoughts and cognitive processes, and can contribute to improvement of occupational performance. A major advantage of utilising computer technology in intervention is that it is portable, flexible and an influential instructional tool to facilitate teaching and learning on an individual or group level (Schoonover and Argabrite Grove, 2015).

In occupational therapy, variables such as exposure to stimulus time, level of difficulty and feedback can be adjusted according to individual needs. The computer provides objective records of the patient’s performance that can be used to motivate and measure progress. Literature suggests that therapeutic involvement using technology should include both computer and non-computerised exercises carefully sequenced and graded (Ross, 1992; Halton, 2008).

Schneck (2010b) reported that computers are highly motivating for children of all ages. She reasoned that the motivational element of computers might improve children's attention to a task and therefore contribute to successful participation. This property of computer-based intervention was also confirmed by Moore and Calvert (2000) when they conducted research on the vocabulary acquisition of children with autism. Furthermore, Schneck (2010b) argues that a computer provides a platform for children to practice skills and to explore learning independently. Hetzroni and Tannous (2004) indicate that computers can also improve children's sense of autonomy and enable them to guide their treatment, which is reported to result in higher levels of independence and improved self-esteem (Ross and Broh, 2000). Schoonover and Argabrite Grove (2015) agreed with Schneck (2010b) as they confirmed that computers are a motivational tool that can assist children to learn new skills and can provide stimulation or experiences that cannot be experienced otherwise.

A property of computer-based learning is the ability to apply repetition and to allow for drill and practice (Schoonover and Argabrite Grove, 2015). Repetition is an essential part of remedial therapy and learning, making computers a suitable tool for remediation purposes. Multisensory and interactive aspects of a computer are also a big asset and can be graded according to the needs of the child (Lee et al., 2013). Todd (1999) agreed that computer intervention could be a valuable therapeutic tool to assist clinicians in engaging children with the therapeutic medium. An additional benefit of using technology is that the visual input can be adapted, the therapist can change the background colours, which may be an advantage for visual perceptual skills training (Schneck, 2010b). Font and page sizes can also be adjusted and that can assist with reducing visual clutter and improving visual attention (Schneck, 2010b). Furthermore, technology can vary from the use of simple systems that precede more complex systems (Schoonover and Argabrite Grove, 2015).

Technology has proven to provide attention training to learners with attentional difficulties and the academic performance of grade one learners. In a study conducted by Rabiner et al. (2010) Computerized Attention Training (CAT) and Computer Assisted Instruction (CAI) were used and improvement in reading fluency as well as academic performance using teachers' rating improved. Additional research was recommended to support these findings (Rabiner et al., 2010).

2.6.3 The effectiveness of incorporating technology in therapy for remediation or rehabilitation of visual perceptual skills

A wide range of medical and scientific databases were searched to identify studies that examined the effectiveness of multimedia use for treating visual perceptual difficulties, but limited research is available on the topic and only six relevant studies were identified. Table 2.1 is a summary of the evidence discussed in the next section. Table 2.2 indicates the level of bias present in the identified studies. Guidelines of a systematic review from the American Occupational Therapy Association were used to formulate Table 2.1 and 2.2 (American Occupational Therapy Association, 2014).

The articles reviewed included populations of children diagnosed with developmental delay, developmental disabilities, autism, handwriting difficulties and cerebral palsy; they received multimedia intervention (Wuanga et al., 2018; Chen et al., 2013; Daley et al., 2014; James et al., 2015; Hetzroni and Tannous, 2004; Cardona et al., 2000)

The objectives for each study differed and outcomes and type of intervention was diverse, although all the studies included technology intervention.

It is important to assess quality of studies in order to provide evidence-based practice (Law and Mac Dermid 2014). All identified studies have been summarised in Table 2.1 and graded according to levels of evidence (Sackett et al., 1996). Quality of studies was assessed by considering the hierarchy of the study design, limitations, consistency and bias. Level I studies provide strong strength of evidence and include systematic reviews, randomised controlled trials and meta-analyses. Level II studies yield moderate strength of evidence and include cohort or case-control studies of nonrandomised groups. Level III studies also provide moderate strength of evidence level and include one group of participants - typical experimental design. Level IV studies offer low-level strength of evidence and include single-subject designs or descriptive studies.

Results of the studies indicated that evidence exists for the effectiveness of multimedia visual perceptual training (Wuanga et al., 2018; Chen et al., 2013; Daley et al., 2014; James et al., 2015; Hetzroni and Tannous, 2004; Cardona et al., 2000). Unfortunately, no published studies were found that considered the effectiveness of multimedia for the treatment of visual perceptual deficits in children diagnosed with

ADHD. There was however one study that considered ADHD, and examined the effectiveness of a computer-based intervention programme that remediates visual working memory in children diagnosed with ADHD (Klingberg et al., 2005)

Table 2.1: Level of evidence on the use of multi-media intervention for the remediation of visual perceptual skills obtained from previous research

Authors:	Level of Evidence/Study Design/Participants/Inclusion criteria	Intervention and Control Groups	Outcome Measures	Results
Wuanga et al. (2018)	Level I Randomised 2 group N=30 control group N=30 experimental group *Inclusion criteria:* Children aged 6-10 years, diagnosis or dysfunction in visual perceptual skills and development, written consent to participate, ability to follow instructions.	*Control Group* Conventional Visual Perceptual Training Programme(CVPTP) *Intervention Group* Game-Based Auxiliary Training System (GBATS) *Intensity* Two 30 minute session per week for eight weeks	• TVPS-3 • Vineland Adaptive Behaviour Scale-Chinese version (VABS-C) • School Function Assessment-Chinese Version (SFA-C)	Both groups improved in total score of TVPS-3 post intervention. The GBATS group improved significantly. Most improvement in the GBATS group was observed in visual discrimination, visual memory, visual spatial relations, visual form constancy and visual sequential memory. Experimental group performed better than control group in the VABS-C and SFA-C therefore illustrating effectiveness for functional outcomes relating to the occupation of academics.
James et al. (2015)	Level I Participants Match pairs Randomised control trial N=102 *Inclusion criteria:* Children diagnosed with unilateral Cerebral Palsy 8-18 years Manual Ability Classification System levels I to III and Gross Motor Function Classification System (GMFCS) levels I or II, Internet access at home	Web based multimodal (upper limb, cognitive, visual perceptual and physical activity) Move it to improve it (Mitii(™) programme. 60% of the programme was cognitive and visual perception. *Intensity* 32 hours over 20 weeks	• TVPS-3 • Motor and process skills (AMPS) • Assisting hands assessment • Jebsen Taylor Test for hand function • Canadian occupational performance measure	Participants achieved higher scores in visual discrimination, spatial relations and figure ground

Authors:	Level of Evidence/Study Design/Participants/Inclusion criteria	Intervention and Control Groups	Outcome Measures	Results
Chen et al. (2013)	Level I Randomised-4 groups N=64 Group 1, n=15. Group 2, n=15 Group 3, n=19 Group 4, n=15 *Inclusion criteria* • Children aged 4-6 • diagnosed with developmental delay • Standard deviation on the TVPS-3 between 0 and -1 • Parental consent	Group 1 received multimedia visual perceptual group training Group 2 received multimedia visual perceptual individual training. Group 3 received paper-based group training Group 4 was the control group and received no intervention. Microsoft Office 2007 PowerPoint software was used to develop the intervention. *Intensity* *40 minute intervention sessions per week for 14 weeks*	• TVPS-3 • TVS-3	All three programmes provided significant differences between pre-and post-test scores. Participants from both multimedia group and individual programmes achieved greater scores than developmental effect. The multimedia group training performed better than individual training. The paper-based programme did not overcome the developmental effect.
Lee et al. (2013)	Level IV Single subject design N=2 *Inclusion criteria* Diagnosed with autism 4-5 years	*Intervention* Move Basic and concepts on Move2 Advance Software *Intensity* 24 sessions for 15 minutes per session. Intervention period unknown	• DTVP-2	Both participants improved on the visual perceptual motor free subtests. Efficacy could not be established.
Cardona et al. (2000)	Level IV Single subject ABA reversal design N=5 *Inclusion criteria* • Children aged 3-5 • Diagnosed with speech and developmental delay • Attentional difficulties according to checklist	*Intervention* Software with the following subdivisions was used: Baileys House, Intellipics, Millie Math House and Kid Pix. *Intensity* Amount of time not documented. Participants completed 14 sessions.	Sitting tolerance Visual attention • Distractions	Increased interest and motivation.

Authors:	Level of Evidence/Study	Intervention and	Outcome Measures	Results

	Design/Participants/Inclusion criteria	Control Groups		
Poon et al. (2010)	Level II Experimental design, randomly grouped participants in two groups N=26 *Inclusion criteria* • 6-7 year old children • Handwriting difficulties • First grade • 1SD or more below mean for MVPT-R, VMI or POET	*Intensity* Participants received 45 minutes intervention per session for eight sessions. *Intervention* Interactive Computerised Handwriting Programme (ICHP)	• VMI 4th edition • Motor Free Visual Perception Test(MVPT-R) • Penmanship Objective Evaluation Tool (POET)	• Significant differences in MVPT mean scores between groups. • Effect of intervention maintained at one-month follow up. • No improvement in VMI
No studies on the effectiveness of multimedia intervention for the remediation of visual perceptual skills could be found, therefore the following study has been included due to considering remediation of cognitive aspects in learners diagnosed with ADHD.				
Klingberg et al. (2005)	Level I Multicentre Randomised Controlled Trial N=53 *Inclusion criteria* • Diagnosis of ADHD • 7-12 years • Access to personal computer with internet at school or home	*Intensity* 90 trails per session (approximately 40 minutes) for 25 sessions *Intervention* RoboMemo Cogmed Cognitive Medical System	• WAIS-RNI testing battery • Digit-Span from WISC-II • Ravens Coloured Progressive Matrices • Conners Rating Scale	• Working memory improved • Inhibition, reasoning and reduced inattentive symptoms observed

Table 2.2 Bias detection

AUTHORS:	Selection Bias				Attrition Bias Incomplete Outcome data		Reporting Bias: Selective Reporting
	Random Sequence generation	Allocation Concealment	Performance Bias: Blinding of Participants	Detection of Bias: Binding of Outcome Assessment	Short term (2-3 wk)	Long Term (>6wk)	

			and Personnel				
Wuanga et al. (2018)	-	-	-	?	N/A	-	-
James et al. (2015)	-	?	-	-	N/A	-	-
Chen et al. (2013)	-	?	-	-	N/A	-	-
Lee et al. (2013)	+	+	+	+	N/A	-	-
Cardona et al. (2000)	N/A	N/A	+	?	+	N/A	-
Poon et al. (2010)	-	+	-	-	N/A	-	-
No studies on the effectiveness of multimedia intervention for the remediation of visual perceptual skills could be found, therefore the following study has been included due to considering remediation of cognitive aspects in learners diagnosed with ADHD.							
Klingberg et al. (2005)	-	?	-	-	N/A	-	-

-Low bias

+ High bias

? not indicated

2.6.3.1 Developmental Delay

Three studies were identified that provided intervention for children with developmental delays (Wuanga et al., 2018; Chen et al., 2013; Cardona et al., 2000). Two studies yielded Level I (Table 2.1) quality of evidence and obtained promising results in favour of multimedia intervention (Wuanga et al., 2018; Chen et al., 2013). These two studies also presented a low bias risk (Table 2.2). Cardona et al. (2000) was classified as a Level IV study due to study design and small sample size; this study obtained a higher bias risk (Table 2.2).

2.6.3.2 Cerebral Palsy

James et al. (2015) was the only study conducted on children diagnosed with CP. This study offered Level I (Table 2.1) quality of evidence for a web-based multi model (upper limb, cognitive, visual perceptual and physical activity) intervention programme. Low bias (Table 2.2) detection was present in this study, therefore contributing to the high level of evidence presented in the study.

2.6.3.3 Autism

Lee et al. (2013) examined the use of multimedia intervention for children diagnosed with Autism. Level IV quality of evidence (Table 2.1) was presented in this study. This study yielded low level of evidence to support the use of computer-based intervention of visual perceptual skills for children diagnosed with Autism, and had limitations of single subject study designs due to small sample sizes. This study posed a high bias risk (Table 2.2) and the findings should be used with caution.

2.6.3.4 Handwriting difficulties

Poon et al. (2010) investigated the effect of a computerised visual perception and visual motor integration training programme on improving handwriting of children with handwriting difficulties. Level I quality of evidence (Table 2.1) was obtained from this study, and low bias (Table 2.2).

2.3.6.5 Attention Deficit Hyperactivity Disorder

No studies were found that investigated the effect of multimedia intervention on the remediation of visual perceptual skills of learners diagnosed with ADHD. A study conducted by Klingberg et al. (2005) provided Level I evidence in examining the effect of a computerised platform for addressing working memory in children diagnosed with ADHD. This study yielded a low bias detection, providing moderate evidence for the use of a computer programme to address working memory in children diagnosed with ADHD.

2.7 SUMMARY

Implications for occupational therapy practice

Research evidence supports the use of technology as a tool to assist children diagnosed with ADHD in their academic occupations (Xu et al., 2002). Technology can be used as an instructional tool, educational tool or a treatment strategy. Technology can be a valuable tool to use when learning new concepts due to the use of colourful graphic material, words and sound with a variety of fonts and animations. Furthermore, it provides structure and organises information, and allows smaller amounts of information to be processed at a time (Xu et al., 2002). Strength of evidence for the use of multimedia intervention is strong for developmental delays yielding two studies in the Level I category and one study in Level IV category (Wuanga et al., 2018; Chen et al., 2013; Cardona et al., 2000). Strength of evidence is moderate for children with handwriting difficulties and CP, receiving multimedia intervention due to one study on Level I (James et al., 2015; Poon et al., 2010). Strength of evidence is low for children diagnosed with Autism receiving multimedia intervention due to lack of evidence, limited size of study and short intervention periods (Lee et al., 2013). Studies suggested that learners were more motivated and interested in engaging in computer-based activities, therefore reducing distractibility and improving performance (Wuanga et al., 2018; Cardona et al., 2000). Reflecting on the evidence presented, technology is a valuable tool to consider for intervention of various disabilities.

Recommendations for future research

Future research is recommended to explore the effectiveness of computer-based and multimedia intervention in improving visual perceptual skills. It would also be of importance to examine specific visual perceptual skills that are most affected when using multimedia as a treatment platform. Recommendations from previous research suggested a longer intervention phase is required to determine effectiveness (Schneck, 2010b). There is currently a gap in the literature on examining the effectiveness of technological approaches for the remediation of visual perceptual skills in learners diagnosed with ADHD. Moderate evidence from Klingberg et al. (2005), together with strong evidence on effectiveness for using multimedia intervention for the remediation of visual perceptual skills in learners diagnosed with developmental delay, might suggest that a computerised platform could be effective in remediating visual perceptual skills in learners diagnosed with ADHD.

Studies that measure visual perceptual evaluation on computer stimulation techniques are scarce. Given the increasing use of new technology together with the amount of time, money and energy spend on the selection and acquisition of hardware and software the issue of therapeutic merit of computer-stimulated techniques should be examined.

CHAPTER 3: OVERVIEW OF STUDY AND PHASE 1

"I`d try to concentrate on what I was reading then I`d get to the end of the page and have very little memory of anything I`d read"

-Tom Cruise

3.1 INTRODUCTION

A concise summary of the general methodology employed in this research project will be discussed. This chapter will also include Phase 1 of the study, the conducting of a retrospective record review to establish the most prevalent visual perceptual difficulties of the population. This information confirmed that visual perception is a challenge for learners diagnosed with Attention Deficit Hyperactivity Disorder, and guided the researcher as to what constructs of visual perception are essential to include in an intervention programme.

3.2 OVERVIEW OF THE STUDY

3.2.1 Research Design

Overall, mixed methods methodology was employed and applied with an adapted intervention research. Mixed methods methodology can be explained as research using a blend of quantitative and qualitative research techniques for data collection (Creswell and Plano Clark 2018). A fixed sequential multiphase design was selected. Mixed method design, where the phases were predetermined and sequential over a period to address the overall intervention programme objective, was used. This is the approach suggested for programme evaluation, which includes quantitative and qualitative approaches in the development, adaptation and evaluation of specific intervention programmes.

Initially a quantitative study to conclude the extent of the problem was conducted. This was followed by a qualitative nominal group design for identification of intervention criteria for specific visual perceptual deficits and a quantitative consensus study using the nominal group technique for the selection and evaluation of a computer programme for the intervention of visual perception. Using these results, an intervention was implemented and evaluated using an alternate group quantitative design (Creswell and Plano Clark 2018).

The intervention phase was guided by an intervention research design, which is a systematic design using specific intervention criteria and purposive change strategies, used to determine the best outcome for each child with ADHD. Fraser and Galinsky (2010) described intervention research as an identified need for intervention, clear goals, activities and intervention principles. The adapted alternate group intervention research design was used in Phase 3 of the study.

3.2.2 Phases of the study

Phase 1: This phase used a quantitative retrospective record review to identify frequent visual perceptual deficits within a sample of 7 to 9 year old learners with ADHD attending a specific LSEN school.

Phase 2: The theoretical foundation of visual perception treatment was identified in this phase using qualitative research methods. The elements (grading, treatment principles and level of activities) required in a visual perception intervention programme were determined using a literature review. This was followed by a nominal group, in which a panel of experts assisted in developing an intervention criteria checklist for specific visual perceptual deficits based on the problems identified in Phase 1. The intervention criteria checklist was used to select the most suitable, commercially available, therapeutic computer programme to treat visual perceptual deficits in 7 to 9 year old learners with ADHD.

Phase 3: The effectiveness of the selected commercially available computer programme was tested in a LSEN school practice setting. An alternate group randomised sample design was used for the effectiveness study. The effect of the intervention on visual perceptual deficits and academic functioning was evaluated using a quantitative research design with an element of qualitative evaluation.

3.3 PHASE 1 METHODOLOGY

3.3.1 Research Design

A quantitative, retrospective record review research design was employed for Phase 1. There is limited research available on how to conduct a record review within a school-based setting therefore literature from medical records was reviewed. Record reviews are of clinical importance to answer clinical questions and source various data types, such as charts, reports or registries, to answer clinical questions. Retrospective record reviews have both advantages and disadvantages; the advantage is that they are more cost effective than prospective studies, the disadvantages are that records are often missing data and they are classified as observational research, which is low level evidence (Patanwala, 2017). Nevertheless, descriptive data on the visual perceptual barriers of learning in learners with ADHD were essential for the intervention planning.

3.3.2 Research Question

What are the visual perceptual challenges of 7 to 9 year old learners, diagnosed with ADHD attending a LSEN school in Gauteng?

3.3.3 Aim and Objective of Phase 1

The aim of this phase of the study was to determine the deficits in visual perceptual components or client factors in learners between 7 to 9 years old, diagnosed with ADHD attending a LSEN school.

Objective:

To determine the most frequent deficits in visual perception client factors in 7 to 9 year old learners with ADHD attending a LSEN school.

3.3.4 Research Setting

The research was conducted at a LSEN school in Gauteng Province, South Africa, a school for Grade 1 to 12 learners with special educational needs. Learners who attend such schools have been diagnosed with barriers to learning and developmental deficits that require specialised support from an occupational therapist, speech therapist and psychologist. Learners aged between 7 to 9 years

(Gr 1-3) were included in the study. There are nine classes for this age group, and the occupational therapists at the school routinely assess Grade 1 to 3 learners once a year using standardised tests. These assessments include tests to identify visual perception deficits in learners

3.3.5 Sampling

The records or learner profiles, which are available for each leaner at the school, were used to source data on their medical history as well as identify their visual perceptual assessments. Data on diagnosis of ADHD and the results of visual perceptual assessments on the Test of Visual-Perceptual Skills-Revised (TVPS-R) for learners 7 to 9 year old in the foundation phase (in Grade 1-3) was collected for a three year period (2010-2012) from records available at the school. A code was assigned to each record to ensure that a record of one learner can only be used once.

Inclusion criteria

- Records of learners diagnosed with ADHD by a neurologist. Learners with co-morbid disorders or differential diagnoses did not meet the inclusion criteria.
- Records of learners who achieved average scores in the non-verbal IQ results.
- Complete available records for the TVPS-R.

Exclusion criteria

- Records of learners with known visual, motor and auditory impairments.
- Records of learners diagnosed with Autism, Asperger's syndrome, epilepsy, known cognitive impairments or pervasive developmental disorder.
- Incomplete records or records with incomplete scoring of the TVPS-R.

3.3.5.1 Sample size

Total population sampling was used, with all profiles available for 7 to 9 year old learners over the period of 2010 to 2012 being included in the study. A sample size of 247 records was available, 118 of which met the inclusion criteria and were reviewed for this study.

3.3.6 Research Instrument

3.3.6.1 Data Collection Sheet (Appendix A)

The data collection sheet included information such as age, gender and diagnosis to confirm inclusion and medication of the learner, which was collected from their learner profile. It was noted if the learners were taking medication including Methylphenidate HCL as this in commonly prescribed for ADHD and assists with concentration during the completion of standardised tests. Papavailiou (2007) compared the effect of psycho-educational training and stimulant medication on the visual perceptual skills of learners diagnosed with ADHD, and found learners performed better on the TVPS assessment after they received stimulant medication and psycho-educational training; between group results were non-significant (Papavasiliou et al., 2007). It is therefore essential to record and considerer the impact that medication might have on visual perceptual skills. It was not possible to exclude records of medicated learners as the majority of those diagnosed with ADHD within this setting were receiving pharmacological intervention; excluding them would have resulted in small sample frame.

The scaled scores of the visual perception assessments using the TVPS-R were then recorded. Although this test has since been updated, it was used at the school for learners over the three-year period when the record review was completed.

The TVPS-R (non- motor) evaluates the same seven visual perceptual subskills, visual discrimination, visual memory, visual–spatial relationships, visual form constancy, visual sequential memory, visual figure–ground and visual closure, that were included in the later TVPS-3 version (Gardner, 1996; Gardner, 1991). The TVPS-R is designed for use with learners between 4 and 12 years of age. While the Cronbach's alpha coefficients were acceptable for this test, Brown et al. (2003) indicated that the total score or TVPS-R's perceptual quotient could not be used as a general summary of performance even though the individual subscale scores were valid. Data were thus collected for each subtest of the TVPS-R but not the total score, as the objective of the study was to determine the frequency of the deficits in the visual perceptual client factors and not the overall perceptual performance of learners with ADHD (Brown et al., 2003).

3.3.7 Research Procedure

Initially (2013) the sample frame was Gr 2 (8-9 years old) learners. After initial data were analysed, the researcher, in consultation with supervisors, decided to expand the population group to Gr 1 to 3 (7-9 years old) learners due to small sample size that met the inclusion criteria. The same data set of records, 2010 to 2012 was used and the record review commenced (2015) to include the Gr 1 and 3 (7-9 years old) learners after the required permission was obtained. More detail about the permission will be discussed in section 3.3.8.

Data were collected for three years retrospectively for the Grade 1 to 3 learner's profiles. These profiles include the learner's application form and medical, therapy, or psychology reports. These profiles are updated at the beginning of each grade (Education, 2014) and information is added each term.

The demographic data and data on diagnosis and medication were collected from the biographical section of the learner profile, while the data on TVPS-R, indicating visual perceptual deficits, was obtained from the occupational therapy assessment reports in the learner profile.

A sample frame was compiled of the total population of 247 learner profiles. This sample frame was in alphabetical and grade order. Thereafter, the learner profiles of the entire population were reviewed to identify if they met the inclusion criteria. If a profile did not meet the inclusion criteria or contained aspects of the exclusion criteria, they were removed from the sample frame list. Once the sample group was identified, learner profiles were reviewed systematically and results entered into an Excel spreadsheet, thereafter the data were analysed and interpreted.

3.3.8 Ethical Considerations

Ethical clearance was obtained for the Gr 2 (8-9 years old) learners in 2012 (Clearance number: M120901). (Appendix B). Ethical clearance was granted for the Gr 1 and 3 (7-9 years old) learners in the 2015 application (Clearance number: M150615) from the Human Research Ethics Committee at the University of the Witwatersrand (Appendix B). The principal of the school gave permission to use records (Appendix D). The research project was approved by the Gauteng Department of Education (Appendix E includes the GDE permission letters). Parental consent was obtained from the parents of children whose records were selected (Appendix C). Assent was obtained from the learners (Appendix C). Confidentiality was ensured as no names were used on the data collection sheets.

3.3.9 Data Analysis

Data were analysed using descriptive statistics, including frequency distribution tables and percentages. The variability for the demographics of the sample as well as the results of the TVPS-R subtests were analysed (Kielhofner, 2006). The scores for learners who were and were not on medication were compared using a Student t -test to establish if this was an interfering variable and whether learners who did not take medication should be excluded.

3.4 PHASE 1 RESULTS

3.4.1 Demographics

Demographic, educational and medical data from the learner profiles is represented in Table 3.1. Approximately two thirds of the learners were male. Learners were equally distributed over Grade 2 and 3, with a higher percentage of Grade 1 learners.

The various medication participants were using is illustrated in Figure 3.1. Ritalin was the most common medication, as used by 56% of the population, followed by 17% of the population who received no medication. The medication that participants were using was predominantly Methylphenidate HCL, as was expected, in the form of stimulants such as Ritalin and Concerta, or norepinephrine reuptake inhibitors (SNRI) like Strattera.

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Table 3.1: Demographic, educational and medical data for the learners (n=118)

		n (%)
Sex	**Females**	24 (20.4%)
	Males	94 (79.6%)
Grade distribution	**Grade 1**	49 (41.5%)
	Grade 2	36 (30.5%)
	Grade 3	33 (28%)
Medication	**Concerta**	21 (18%)
	Ritalin	66 (56%)
	Strattera	7 (6%)
	Herbal	4 (3%)
	None	20 (17%)

3.4.2 Test of Visual-Perceptual Skills-Revised (TVPS-R)

Occupational therapy assessment reports from 2010 to 2012 were analysed. The scaled scores ranged from 1 to 20 and were used for interpretation (Gardner, 1991; Beery, 1997). These scores show the extent to which a child`s performance differs from the average performance of learners of the same chronological age in the norm group. Scaled scores of 10 represent average performance on subtests (Gardner, 1991). Standard error of measurement (SEM) takes degree of chance fluctuation into account and may differ from the “true” score. The standard error of measurement for each subtest is two, therefore scores of eight and above can be interpreted as functional (Gardner, 1991; Beery, 1997). A mean score of below eight was therefore accepted as a cut off, indicating deficits in visual perceptual function.

The mean scaled scores for all subtests on the TVPS-R for the learners were below eight with the exception of visual figure–ground and visual form constancy. This indicated this sample of learners presented with visual perceptual deficits. Since no statistically significant differences were found between the learners who were not taking any medication, indicating that the use of medication did not have any impact on assessment results (Table 3.2). All 118 records of learners’ results were analysed.

Table 3.2: Difference in scaled scores on the Test of Visual-Perceptual Skills-Revised for learners who do and do not take medication

	Take medication (n=97)		Do not take medication (n=20)		p-value
	Mean	SD	Mean	SD	p
Visual Discrimination	7.59	2.33	6.90	2.38	0.06
Visual Sequential Memory	6.77	3.45	6.95	2.94	0.83
Visual Memory	6.84	3.09	6.35	3.40	0.52
Visual Form Constancy	8.82	1.82	8.20	1.70	0.16
Visual–Spatial Relationships	7.82	2.87	6.95	2.94	0.22
Visual Figure–Ground	9.17	2.65	8.85	2.56	0.61
Visual Closure	7.02	2.95	7.10	3.33	0.91

The percentage of the sample records that scored below eight on all subtests of the TVPS-R are represented in table 3.3, with the subtests ranked in order of the percentage deficits. Therefore, all subtests that have an average of above 50% can be considered as prevalent in visual perceptual deficits of this sample.

Table 3.3: The percentage of sample scoring below a scaled score of 8

Perceptual construct:	n %
Visual Memory	86 (73%)
Visual–Spatial Relationships	82 (70%)
Visual Closure	81 (69%)
Visual Discrimination	75 (64%)
Visual Sequential Memory:	72 (61%)
Visual Form Constancy	58 (49%)
Visual Figure–Ground	48 (41%)

3.5 SUMMARY

Results of Phase 1 provide evidence to suggest that learners diagnosed with ADHD have visual perceptual deficits. The most prevalent visual perceptual deficits in the sample of learners diagnosed with ADHD at the school in the current study included visual discrimination, visual closure, visual spatial relations, visual memory and visual sequential memory. Literature confirmed the findings with the exception of visual closure and will be discussed in Chapter 6. Phase 2 will therefore focus on the identification of intervention criteria and selection of an appropriate computer programme for the remediation of visual perceptual skills.

CHAPTER 4:
PHASE 2: DEVELOPMENT OF INTERVENTION CRITERIA CHECKLIST AND COMPUTER PROGRAMME SELECTION

"If a child cannot learn the way we teach we maybe we should teach the way they learn"

-Ignacio Estrada

4.1 INTRODUCTION

This phase of the study was completed in two sections. First an intervention criteria checklist was developed by analysing literature and using the Nominal Group Technique (NGT) for validation. This literature review differs from Chapter 2 and focused on developing intervention criteria containing explicit practice principles, goals and activities. The NGT is a group process that follows a structured format in order to generate solutions and problem solve by obtaining input of various experts (Potter et al., 2004). Thereafter an appropriate computer programme was evaluated and selected in collaboration with an expert. This chapter highlights the literature review used to identify intervention criteria for visual perceptual deficits in learners with ADHD identified in Phase 1 of the study, which were presented to the nominal group to obtain agreement on criteria for selection of a computer-based intervention programme to treat visual perceptual deficits.

4.2 DATA COLLECTION PROCEDURES FOR PHASE 2

Figure 4.1 provides a description of the data collection procedures in Phase 2. The data collection procedures have been included in the first section of Chapter 4 to provide a clear understanding of Phase 2 because it was complete in two parts.

The first step in the data collection procedure for Phase 2 was to review the literature and to create a data base of information that contained intervention criteria (intervention principles, grading principles and activity ideas). The purpose of this section was to establish a theoretical background for the NGT to utilize.

Upon completion of the literature review the nominal group was used to establish an intervention criteria checklist (Table 4.10-Table 4.13) for these visual perception deficits. More detail regarding how the weighting was determined is explained in Step 6 of the NGT and in section 4.5.3.4. The NGT allowed participants to validate available intervention criteria and to add expert knowledge to expand the criteria that was established from the literature.

The intervention criteria were used to evaluate local computer programmes and justify the selection of one programme for the treatment of visual perceptual dysfunction in 7-9 year old learners diagnosed with ADHD. The purpose of the intervention criteria was to serve as a fidelity tool to assist clinicians in making informed decisions regarding intervention and contribute to evidence-based practice.

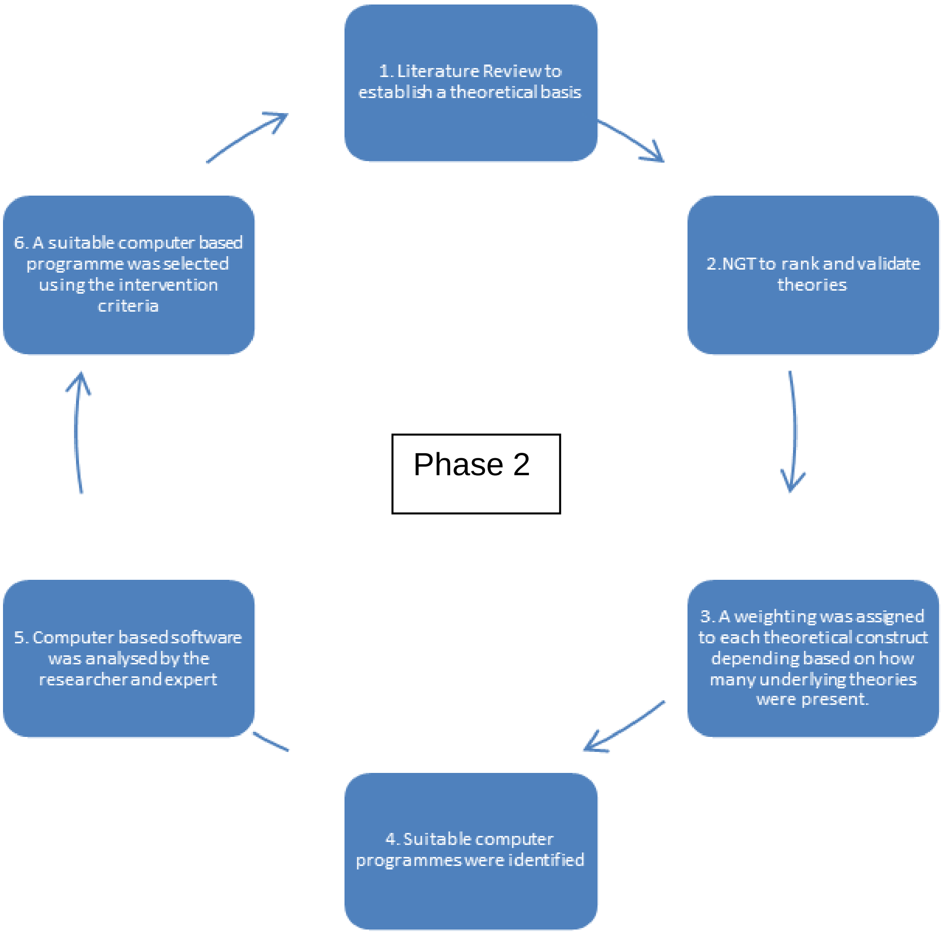


Figure 4.1 Data Collection procedures for Phase 2

4.3 LITERATURE REVIEW TO DETERMINE INTERVENTION CRITERIA FOR VISUAL PERCEPTUAL DEFICITS

4.3.1 Introduction to literature review

In order to formulate a sound theoretical basis for intervention to overcome difficulties with visual perception in children diagnosed with ADHD, occupational therapists incorporate theories of human occupation, activity analysis, cognitive and developmental psychology, neurology, education and optometry. A literature search identified published studies and information on visual perception, child development and cognitive development. The intervention criteria that emerged from the literature allowed for the identification of treatment principles, grading and activities that formed the presentation for the nominal group. The researcher searched the Science Direct database as well as the SAGE Journal database and used the following key words: visual perception, perceptual learning, learning principles, visual perceptual frame of reference, home programme, intervention programme design.

Individual visual perceptual components play a role when assessing visual perceptual skills to measure progress. These individual constructs are therefore of clinical importance and this review considers intervention criteria for visual memory, visual discrimination, spatial relationships and visual closure which were identified as the most common deficits in Phase 1 for the learners with ADHD (Martin 2006) (Table 4.1- Table 4.4). However in order to formulate a holistic approach, the interrelatedness of visual perceptual skills was considered but not restricted to the formulation of the intervention criteria checklist for visual perceptual skills of learners diagnosed with ADHD. Theories included in Table 4.1- Table 4.4 refers to general management of visual perceptual intervention and are not specific to computer-based intervention (due to the lack of research on this topic).

4.3.2. Visual Memory

Visual Memory treatment principles, grading and activities are presented in Table 4.1. Treatment principles, grading and activities for visual sequential memory are included under visual memory because visual memory is required for the development of visual sequential memory.

Table 4.1: Treatment principles, grading, and activity ideas for visual memory

VISUAL MEMORY		
TREATMENT PRINCIPLE	**GRADING**	**ACTIVITY IDEAS**
General visual memory treatment principle • Maintenance rehearsal or pure repetition can be used to hold information for immediate use (Kramer P and Hinojosa J, 1993). Visual memory can be improved by repetition (Todd, 1993) Similar concepts or activities can be used in the programme. • .The participant should be exposed to practicing long term and short term memory (Witthaus, 2002).	***General visual memory grading*** • The amount of visual input to recall can gradually increase in relation to skill (Witthaus, 2002). • Visual sequences is a grading from recalling single visual items to multiple visual items (Todd, 1993) • The amount of facts or objects that participant has to recall will be increased according to skill (Todd, 1993).	• Going somewhere game for example “going to the zoo”. The participant will see various images, one at a time related to the theme. They have to recall the images after each new picture shown and at the end recall all the pictures (Witthaus, 2002). • Memory matches game (Witthaus, 2002) • Flash cards of shapes, letters, numbers words will appear on the screen, participants have to recall the sequence (Witthaus, 2002)

4.3.3 Visual Discrimination

Visual Discrimination treatment principles, grading and activities are presented in Table 4.2. Mastering the identification of similarities and differences are important skills in the development of visual discrimination. Similarities refer to identifying similar or identical elements in objects or pictures. Differences refer to identifying variances in objects or pictures.

Table 4.2: Treatment principles, grading and activity ideas for the treatment of visual discrimination

VISUAL DISCRIMINATION		
TREATMENT PRINCIPLE	**GRADING**	**ACTIVITY IDEAS**
• Visual stimuli should be simply presented in a clearly organised manner (Schneck, 2010a). • Activities that allow participants to identify similarities and differences between objects (Witthaus, 2002). • Activities that allow differentiation to take place and address the skills of recognition, matching and sorting (Todd, 1993) .	• Visual discrimination is enhanced when the visual stimuli are presented from general to specific, whole to parts, familiar to unfamiliar and concrete to abstract (Todd, 1999; Schneck, 2005). • General to specific (Schneck, 2010b) • Whole to parts (Schneck, 2010b) • Concrete to abstract (Schneck, 2010b) • Participants should initially identify gross similarities/differences of objects and later on identify smaller similarities/differences (Witthaus, 2002). • Increase the amount of similarities/differences between objects as the learners skill improves (Witthaus, 2002). • The learner should be exposed to 3D and 2D activities involving visual discrimination (Witthaus, 2002). Exposure to 3D activities will occur during traditional therapy.	**Similarities** • Design a square grid with different pictures. Design a set of cards that is similar to each picture on the grid. The participant should match the cards with the grid (Grove and Hauptfleisch, 1978). • Sorting of objects. Participants should classify objects according to size, shape, colour or category (Kurtz, 2006; Grove and Hauptfleisch, 1978) • Picture-dominoes. Let the participant fit appropriate pictures together (Grove and Hauptfleisch, 1978). **Differences** • Show the participant pictures that are in a row. One of the pictures should not belong there. The participant must indicate which picture doesn't belong there (Grove and Hauptfleisch, 1978). • Show the participant pictures that are in a square grid. Ask participant to indicate what pictures are identical to the first one in each row (Grove and Hauptfleisch, 1978). • Show participant two pictures and ask them to indicate all the mistakes made on the second picture (Grove and Hauptfleisch, 1978).

4.3.4 Spatial Relations

Visual spatial skill treatment principles, grading and activities are presented in table 4.3.

Table 4.3: Treatment principles, grading and activity ideas for visual spatial relations

VISUAL SPATIAL RELATIONS		
TREATMENT PRINCIPLE	**GRADING**	**ACTIVITY IDEAS**
• The participant has to orientate their own body in relation to objects using the following concepts: " on, under next to, behind, in front , inside, above, between, over, near, far" (Witthaus, 2002):270) • The participant has to learn to orientate one object to another in relation to words such as on, under, next to, behind, in front of ect (Witthaus, 2002). • The participant has to learn to notice the difference in spatial orientation of objects (Witthaus, 2002)	General grading principles will be applied here.	• Show an object on the screen and ask participants if it is on their left or right side. • Show objects in relation to each other and ask participants to give the correct terminology of the objects relation to another object. • Dot to dot activities (Witthaus, 2002) • Show similar pictures and ask participants to choose the one that is spatially disorganised. (Witthaus, 2002) • Copy block design patterns (Kurtz, 2006). • Mazes (Kurtz, 2006).

4.3.5 Visual Closure

Visual closure treatment principles, grading and activities are presented in table 4.4

Table 4.4: Treatment principles, grading and activity ideas for visual closure

VISUAL CLOSURE		
TREATMENT PRINCIPLE	**GRADING**	**ACTIVITY IDEAS**
• Make sure the participant sees the whole first and then the parts for instance if the participant has to build a puzzle to first see the big picture and then complete the puzzle (Schneck, 2010b) • Make sure the missing part or correct response is indicated for the participant to receive the feedback (Schneck, 2010b). It is recommended that upon a certain amount of unsuccessful attempts the programme demonstrates the correct response to facilitate the learning process.	See general grading principles	• Puzzles(Kaldenberg, 2005) • Connect the dots (Witthaus, 2002) • Word searches (Kaldenberg, 2005) • Block designs (Kaldenberg, 2005) • Show the participant incomplete pictures and ask them to identify the completed pictures (Witthaus, 2002) • Participant is presented with half pictures and they have to identify the other half and match it with existing half (Witthaus, 2002) • Present participants with a picture that has something missing (Witthaus, 2002). • They have to identify the missing object by drawing it or clicking on the empty space (Witthaus, 2002)

4.3.6 Other components to be considered in intervention of visual perception

4.3.6.1 General grading principles according to cognitive and visual perceptual development and the Framework of Hierarchical Development of Visual Perception

Theories of visual and cognitive development were considered in the intervention criteria which were presented. Piaget`s theory of learning highlights age appropriate actions and milestones which are accomplished at certain critical time frames according to age and developmental level of the child (Newman and Newman 1999; Pulaski, 1971; Wait et al., 2003). Changes in development take place during these critical time frames in the social, cognitive, affective and physical development. Piaget believed that hierarchical development of cognition advanced from simple to complex, from concrete to abstract and from personal to worldly (Law et al., 2005). A child learns concepts first in relation to self and then transfers them to words or symbols (Pulaski, 1971).

Piaget's theory is considered to be classical concepts which view development from a constructivism viewpoint and are therefore suited as a foundation for establishing intervention criteria. It is essential that this theory be considered when selecting an appropriate computer programme so the intervention can interact with the thinking child at their appropriate developmental level (Law et al., 2005). The learning theory of Mosey (1986) considers an applied frame of reference important in providing structure in linking learning theories to purposive activities. The Hierarchical Visual Perceptual Framework in collaboration with the learning theories will therefore assist with the process of acquiring specific skills needed for the successful participation in activities (Mosey, 1986). Table 4.5 and Table 4.6 presents the application of Piaget's and Mosey's learning theory considered for the development and grading principles for visual perception for this study. Both of these tables present general grading principles however they were considered separately due to the application of two different theorists using the developmental frame of reference and learning frame of reference.

Table 4.5: General grading principles - Framework of Hierarchical Development of Visual-Perception and learning theories (Piaget's learning theory)

GENERAL GRADING PRINCIPLES
• **Simple to complex** Grading from simple to complex should be applied to the intervention criteria by grading from one item to two or more. Simple pictures with minimum visual clutter can be used and graded to pictures with more information and visual clutter. Primary colours can be used first followed to secondary colours. Symbols can be graded from a straight vertical line to a circle to a cross, square, horizontal line, triangle and lastly a diamond shape(Todd, 1993; Schneck, 2010a; Witthaus, 2002; Pulaski, 1971). • **Familiar to novel** A child develops the ability to relate to objects and to recognise familiar objects in two dimensions when they interact with objects that can be seen, felt and manipulated. It is therefore recommended that themes that are familiar to the learners are used in the selected programme.. The learners should have had previous knowledge and multisensory experience with topics presented in the selected programme. Activities can be graded from concrete to abstract by introducing familiar objects first and then grading to unfamiliar. Photographs or realistic drawings can be introduced first followed by abstract pictures. Introduction of shapes should follow with symbols thereafter letters and words (Pulaski, 1971; Witthaus, 2002; Todd, 1993). • **Personal to worldly** Grading from personal to worldly will commence with body concepts followed by shapes, pictures, letters and numbers (Witthaus, 2002). Visual perception develops from general to specific, whole to parts, concrete to abstract and familiar to novel (Schneck, 2005). • **General to specific** Recognition of objects is often learned within the context of a familiar activity. As experiences with objects increase the learner will begin to group objects that are visually similar into what Piaget (Pulaski, 1971) calls classes (Todd, 1993). Shared characteristics or similarities of items are learned when classifying them. As learners become more advanced at classifying items they learn that attention is paid not only to the overall shape but also to items specific characteristics The ability then develops to analyse the whole against the part The concept of grading from general to specific relates to the grading of simple to complex. A learner has to identify, distinguish and discriminate detail of the visual stimuli when grading takes place from general to specific or from simple to complex. Shapes and pictures with little visual clutter and detail will be graded to pictures with more detail and features. Participants will be expected to give more detailed feedback in terms of the observations of visual discrimination and visual memory activities (Todd, 1993; Witthaus, 2002; Schneck, 2005). • **Whole to parts** In order to understand the relationship of the whole to its parts in visual discrimination it is required not only to recognize whole objects but also to create awareness of spatial organization and the association between the various elements. Participants can be shown the whole of visual closure activities first and then required to fit the parts to the whole. Familiar to novel grading is similar to the cognitive grading of personal to worldly (Schneck, 2005; Witthaus, 2002; Todd, 1993)

Table 4.6: General principles - Framework of Hierarchical Development of Visual-Perception and learning theories (Mosey's learning theory)

GENERAL INTERVENTION PRINCIPLES FRAMEWORK OF HIERACHICAL DEVELOPMENT OF VISUAL PERCEPTION AND LEARNING THEORIES
The principles of learning from Mosey (Mosey, 1986) is suggested to be used in the visual perceptual frame of reference: • Activities should be selected that is age, gender appropriate and reflects a learner's interest. Activity choice should be carefully selected and discussed in the next section. • Motivation to engage and complete tasks plays a role in the learning process. Motivational incentives can be imbedded in the programme; this will be discussed in more detail in another section. • A child learns from his current level of functioning and then continues at a pace that is comfortable for them. The selected programme should therefore be graded from simple to complex as mentioned in the previous section. This will enable the participants to engage in the programme on an age appropriate level. • Learning is enhanced if the child receives positive reinforcement and feedback as consequence of his actions. Motivation and feedback should be embedded in the programme and will be discussed in detail in another section. • Repetition and practice are important aspects of learning. An element of repetition should be embedded in the programme. It will be useful if the programme can track what activity each participant did last and revises previously successful activities before commencing with new activities. • Presenting participants with an example, trail and error, shaping is important learning techniques. Thinking skills are facilitated by the process.

4.3.6.2 Dynamic Systems Theory Model of Visual Perception (DSTMVP)

The Dynamic System Theory Model of Visual Perception was discussed and explained in Chapter 2. This theory is an integral part of the intervention criteria. The Dynamic System Theory Model of Visual Perception emphasised that vision and ocular-motor abilities, sensory and cognitive components are part of a complex system and a dynamic interactive process that enable vision (Coté, 2015) (Table 4.7).

Table 4.7: Intervention criteria– application of Dynamic Systems Theory of Visual Perception (Coté, 2015)

GOAL	ATTENTION AND KNOWLEDGE	RETINAL IMAGE
Activities should be goal directed (Coté, 2015; Schneck, 2005).	Activities should attract visual attention (Coté, 2015; Witthaus, 2002)	Recognition of objects to stimulate the foveal vision Application: familiar objects that can be recognised (Coté, 2015; Witthaus, 2002).
Goals can occur on different levels (Coté, 2015)	Activities should be within the child's frame of reference to allow them to apply previous knowledge (Coté, 2015; Pulaski, 1971).	Spatial location and movement to stimulate parafoveal vision Application: Animations that can move across the screen. Objects that needs to be dragged over the screen from one space to another (Coté, 2015).
EARLY VISUAL PROCESSES	**LANGUAGE AND CULTURE**	**MOTIVATION AND EMOTIONS**
Activities that involve visual memory should be included (Coté, 2015; Witthaus, 2002)	Auditory instructions of the programme should provide instructions in the language of teaching and learning of the learners. Activities should be acceptable and identifiable for all cultures (Coté, 2015).	A programme should include positive reinforcement that can elicit a good emotional response (Coté, 2015; Kotaman, 2018)
TACTILE AND PROPRIOCEPTION	**POSTURE AND MOVEMENT**	
Activities should include a tactile component and images presented must be in different spatial orientation and sizes (Coté, 2015; Witthaus, 2002)	Activities should be presented on a multimedia device that can offer a stable base of support. Activities should include elements of movement of images across the screen (Coté, 2015; Schneck, 2005)	

4.3.7 Important elements a multi-media intervention programme should contain

4.3.7.1 Oculomotor function

Learners diagnosed with ADHD are more predisposed to visual tracking problems than their typical peers. It has been hypothesised that learners with ADHD have difficulties in suppressing unwanted reflexive saccadic eye movements (Douglas et al., 2003; Hamker, 2003). If a learner cannot maintain a visual fixation, they will have difficulty locating things, kicking a ball, writing and reading.

4.3.7.2 Visual Inattention

In children with ADHD as indicated in Chapter 2 visual inattention is an overriding deficit that affects all visual perceptual skill acquisition and therefore principles to address this component must be included if a holistic view is to be taken. The guidelines to reduce visual distractibility suggested by Schenck (2010a) are presented in Table 4.8

Table 4.8: Intervention criteria for oculomotor and visual attention deficits when remediating visual perception in learners diagnosed with ADHD

GUIDELINES WHEN USING ACTIVITY WORKSHEETS OR GRAPHIC MATERIAL TO REDUCE VISUAL DISTRACTIBILITY:
• High contrast images should be used that define boundaries and attracts the eye, it should provide clear input (Schneck, 2005). • Outlining in heavy lines can attract visual attention to appropriate detail (Todd, 1999). • Covering work that is finished or net yet finished may reduce visual distractions (Kurtz, 2006; Mosey, 1986). • The position of items in the visual array can assist performance. Items that are arranged vertically for comparison are simpler to see that items organized horizontally (Todd, 1999).

4.3.8 Important elements of a computer programme for the remediation of visual perceptual skills in children diagnosed with ADHD

In order to accommodate the visual perceptual deficits related to ADHD, learning theories and certain requirements in relation to the computer-based programme were identified in terms of the intervention criteria described above (Table 4.9).

Table 4.9: Elements of a computer programme for the intervention of visual perceptual skills in children diagnosed with ADHD

Feedback and motivation	Instructions and description
Feedback should be given during each activity (Gottfried et al., 1994; Guéguen et al., 2015). A correct response should receive a positive auditory response and an incorrect response should receive an encouraging response (Guéguen et al., 2015). It is important that participants receive constant feedback and motivation of performance. The level of difficulty should be adapted to the participant's level of skill (Schneck, 2010b). Motivation and interest in the activity is required for effective learning (Wait et al., 2003; Schneck, 2005; Coté, 2015).	Ayres (1972) described as early as 1972 that the visual system has neural interconnections with all the other sensory systems. It is therefore vital to involve other sensory systems when treating the visual system. Intersensory integration plays a significant role in the learning process. The researcher will therefore select software that incorporates other sensory systems. Instructions should be presented to participants by means of visual and auditory input (Cardona et al., 2000). All the participants will use earphones to receive the instructions, this will also aid in minimizing and filtering distractible auditory information from the environment and optimising the learning experience. An example of each new activity should also be provided as described in the Piaget learning theory (Pulaski, 1971). Participants will get the chance to practice each activity through demonstration before commencing each new activity

Once the intervention criteria and the important elements of the computer-based programme had been identified from the literature these were combined into a power point presentation. This was used in the nominal group with expert therapists to develop the intervention criteria checklist on which the selection of the local computer programme for this research was based.

4.3 RESEARCH DESIGN

A qualitative nominal group technique (NGT) design was employed for Phase 2 of the study. This included ranking the intervention criteria for specific visual perceptual deficits by experts in a nominal group. This was done to establish consensus on the intervention criteria required in order to develop an intervention criteria checklist. The checklist was used to evaluate the computer-based visual perceptual programmes (Potter et al., 2004). The NGT was suited to this phase of the study as it consists of a small group of experts. The individual judgments were used in which it was effectively pooled to rank a set of intervention criteria. The technique includes structured brainstorming where all participants contribute in the construction of ideas (Abdullah and Islam, 2008). Potter et al. (2004) pointed out the advantages of using the NGT is that a single meeting can deliver immediate outcomes; it is also time and cost effective.

The NGT was the most suitable design to use that address the uncertainty which existed about the possible solution for which intervention criteria should be used in the selection of the computer-based programme to be researched in Phase 2 of the study. The technique was helpful in exploring solutions and establishing priorities using a group of participants with expertise in the topic (Delbecq et al., 1975). This structured process was used as it minimises potential researcher bias.

Intervention criteria related to the defined visual perceptual problems identified in Phase 1 including principles, grading and level of activities were needed for the experts invited to the nominal group to consider. Therefore, a literature review of intervention criteria for visual perception was completed.

4.4 RESEARCH PROCEDURE

4.4.1 Sampling

Literature recommends that when using the nominal group technique the number of participants should range from six to nine. When using the nominal group technique participants should be selected on the basis of their expertise in the area. The researcher collaborated with the School Based Occupational Therapy Group (SBOT) and the Occupational Therapy Association of South Africa (OTASA) to recruit participants. Purposive sampling was used to recruit experienced therapists that met the inclusion criteria below (Kielhofner, 2006).

Inclusion criteria:

- Occupational therapists working at a LSEN school in Gauteng.
- Therapist that are currently working with foundation phase learners (Gr 1-3).
- Therapist with a minimum of ten years of experience working with foundation phase learners diagnosed with ADHD.
- Therapists that have a postgraduate qualification or certified in specialized fields such as sensory integration or neuro developmental therapy.
- Therapists that have experience in treating visual perceptual dysfunction.

Invitations were sent to OTASA members stating the inclusion criteria (Appendix F). The SBOT chairperson was responsible for selecting and recruiting suitable participants and she verified that they met the inclusion criteria. Selection of participants for the Nominal Group Technique was therefore not done by the researcher to exclude any possible bias. Eight participants that met all the inclusion criteria for the nominal group from therapists agreed to participate in the study.

4.4.2 Ethics

Permission for this phase of the study was granted by the Human Research Ethics Committee for at the University of the Witwatersrand (M150615) (Appendix B). The researcher provided an information sheet to all invited occupational therapists and they were asked to give informed consent (Appendix G). They were made aware that confidentiality cannot be ensured due to the nature of the group and they may withdraw without consequence.

4.4.3 Pre-Nominal Group Questionnaire (Appendix J)

The participants had given signed informed consent they were required to complete a demographic questionnaire and a pre-nominal group questionnaire before participating in the nominal group (Appendix G, Appendix J). The researcher drew up the pre-nominal group questionnaire using *Survey Monkey*® which consisted of multiple choice, open ended and close ended questions. The information derived from the questionnaire provided insight into participants' knowledge and use of the electronic media for the intervention of visual perceptual dysfunction. The purpose of the questionnaire was establishing the level of knowledge and previous experience that participants had using multi-media tools as part of an intervention strategy. It provided a baseline as to how much information should be presented to the nominal group.

4.4.4 Nominal group

The School Based Occupational Therapy Group used a neutral venue for the nominal group. The NGT took place for three and a half hours in a room at school that was a neutral venue for the participants. The set-up was in a U-shape or horseshoe shape. This set-up assisted the researcher to interact with the entire group; it encouraged systematic discussion and participation. A laptop computer, audio-visual projector and handouts were used for the group. The six steps of the nominal group technique were followed (Abdullah and Islam, 2008).

4.4.4.1 Step 1: Opening the session

All participants were thanked for attending. The purpose of the session was explained and a short presentation defining visual perception, clarifying constructs and disusing what role it plays in the academic achievement of learners diagnosed with ADHD as well as the results of Phase 1 of the study was completed. The intervention criteria (treatment principles and grading) for the specific visual perceptual deficits identified in Phase 1 of the study based on the literature review as well as the theoretical foundation for these were then presented to participants (Appendix H). The activities identified in the literature review were also presented to provide examples and help group members conceptualise the treatment principles and grading. Participants were not asked to identify activities as part of the nominal group as these would be determined by the computer-based programme selected based on the intervention criteria related to the treatment principles and grading.

The focal questions were then asked.

The primary focal question was: “What are the most important intervention criteria (treatment principles and grading) for each of the visual perceptual deficits identified in Phase 1 of the study (visual memory, visual closure, visual discrimination and visual spatial relations as well as visual attention) when working with learners diagnosed with ADHD?”

The secondary focal question was: "What important elements should a multi-media intervention programme contain for the remediation of visual perceptual skills for learners diagnosed with ADHD?"

The participants were asked to validate the intervention criteria and rank them in order of importance. They also had the opportunity to generate their own ideas in step 2 if these haven't been included in the presentation.

4.4.4.2 Step 2: Silent generation of ideas in writing

The participants were allowed 15 minutes to rank the specific intervention criteria as presented in the group for each of the visual perceptual deficits identified in Phase 1. They were asked to generate any additional ideas and criteria and the number of ideas per participant was unlimited. This step was completed in silence and no discussion was permitted.

4.4.4.3 Step 3: Round-robin recording of ideas

The participants were asked to present any new ideas and provide the theoretical framework they were based on if this differed from that supporting the presented intervention criteria. Participants also had the opportunity to suggest the removal of any of the current treatment or grading principles.

Each participant was then asked to select intervention criteria from their list generated in step 2. The selected intervention criteria were recorded on a marker board in full view of the entire group for treatment principles and grading for each of the visual perceptual components (visual memory, visual closure, visual discrimination and visual spatial relations as well as visual attention). Collecting the selected intervention criteria in this round robin fashion continued until all the concepts on participants' lists were exhausted. Any criteria that are considered not valid were listed separately and new criteria were added (Appendix I).

4.4.4.4 Step 4: Serial discussion on the ideas

This step focused on clarifying each intervention criterion. The facilitator started from the top of the list and asked participants if the meaning was clear to them. Any ambiguity on any criterion was discussed and clarified.

4.3.4.5 Step 5: Voting to select the most important ideas

The participants were then asked to vote on the ranking of the intervention criteria for each component from the list generated in Step 3. Based on treatment principles or grading each intervention criterion was ranked in order of importance based on this vote. An agreement of 80% in terms of ranking for the criteria was accepted. Participants had to show their agreement after each discussion with the show of hands.

4.3.4.6. Step 6: Discussion on the selected ideas

Findings were consolidated and summarised in a word document which was projected in the view of all participants. This document constituted the intervention criteria checklist against which all computer-based programmes were evaluated.

On the checklist the highest number (weighting) was assigned to the criterion voted most important and the rest followed in descending order with the lowest number assigned to that considered the least important. If there was more than one criterion with the same level of importance then the same weighting was applied. Any criterion that was considered invalid was eliminated upon discussion and mutual agreement of participants. The weighting of each criterion was awarded based on clinical reasoning and experience of participants and is explained in 4.5.3.4. The discussion of the weighting is in Chapter 6. The clinical importance of the weighting was to determine the order of importance of the theoretical constructs. This impacted on the final score that each computer-based programme obtained upon using the computer-based evaluation form (Table 4.14 and Table 4.15).

4.5 FINDINGS

4.5.1 Introduction

This section will report on the results NGT as well as the pre-nominal group questionnaire. Results of the selection an appropriate computer programme for the remediation of visual perceptual skills for learners diagnosed with ADHD will also be reported on.

4.5.2 Results of Pre-Nominal Group Questionnaire

All the participants completed the questionnaire. Only 37.5% (3) participants indicated that they have used electronic media to remediate visual perceptual skills. The other participants 62,5% (5) reported that they have never used electronic media for the remediation of visual perceptual skills and that they don't have knowledge about the treatment modality.

Participants that used electronic media for treatment indicated that each used different programmes for intervention and their intensity of use also varied. Perceptual skills were remediated using various *i-pad* applications and computer programmes. Participants stated that they don`t have any protocol or guidelines for the use of electronic media. One participant reported that she uses electronic media weekly for therapy and the other participant said they use it once a month. The amount of time learners are engaged in electronic media during therapy varied from 15 minutes to 40 minutes per session.

The participant who used pre-school educational software and said it was very user friendly and she was extremely satisfied with the programme. She reported that therapy is conducted on a laptop in individual sessions and she has observed progress in learners diagnosed with ADHD. She said they improved on their activity speed and accuracy. A second participant used the two different multimedia devices for the treatment of visual perceptual skills. She reported that the *Cami Perceptual Skills Builder*™ programme was very user-friendly and that she was quite satisfied with the programme. Intervention that she provided was on a laptop and tablet in individual and group sessions. She reported that learners with ADHD are more motivated to do remediating visual perceptual exercises and that she can see a functional difference. She also reported that the *i-pad* games are not as user-friendly and she is somewhat satisfied with them. Therapy was conducted in a group and progress was observed of learners diagnosed with ADHD. A third participant was very satisfied with the *Sea World Adventures*™ computer-based programme she used as this was a perceptual skills programme that she found very user-friendly. She reported that therapy was conducted on a laptop within a group setting. She reported good progress was made, the programme provides positive reinforcement and that improves participation and skills of learners.

4.5.3 Findings from the nominal group

4.5.3.1 The most important intervention criteria (treatment principles and grading) for components of visual perception

During Step 3 of the NGT participants had the opportunity to present any new ideas that could be added to the intervention criteria. Participants could also suggest removal of irrelevant treatment or grading principles.

In answer to the first focal question the participants added intervention criteria and did not discard any criteria that were presented for each of the visual perceptual deficits identified in Phase 1 (visual memory, visual closure, visual discrimination and visual spatial relations) when working with learners diagnosed with ADHD. The researcher confirmed all additional criteria were valid by finding research and literature to support each one.

Visual memory

Additions to the presented intervention criteria suggested by the nominal group participants in relation to treatment and grading principles for visual memory were that content of the computer-based programme should be interesting, capture the visual attention of learners and maintain their motivation levels. Todd (1993) confirmed that visual memory could improve when visual attention, motivation and comprehension are present. The participants also recommended that the timeframe be adjusted when presenting visual stimuli to remediate visual memory and this time should be graded by reducing the time the stimulus was presented as providing less time will make the activity more complicated. Witthaus (2002) agreed with this concept and recommended that the time the learner has to remember facts or objects should be manipulated; they should require less exposure to the stimulus the more advanced they get.

Group members recommended that multiple sensory systems should be involved with treating visual memory which was supported by Todd (1993) reported that visual memory could improve when combined with another sensory system. It was suggested that auditory and tactile input provided by the computer-based programme could therefore enhance the visual memory.

Visual-Spatial Relations

The nominal group participants recommended the following addition for the intervention of visual-spatial relations. They pointed out it is important that the computer programme presented stimuli for the learners to visually scan a page from left to right when engaged in visual spatial relation activities. Schneck (2005) confirmed that learners should be instructed to scan the screen visually from left to right. Learners with visual spatial problems often do not plan where to start an activity and will start anywhere, which will result in poor quality of execution and missing out important questions, words or numbers.

No changes or additions were proposed for grading principles of visual spatial relations.

Visual Discrimination

No additions or changes to the treatment principles or grading principles of the theoretical framework of visual discrimination were recommended. However it was recommended that grading principles of general to specific, whole to parts and concrete to abstract be moved to the general grading section and not be duplicated under visual discrimination.

Visual Closure

No changes or additions were recommended for visual closure treatment and grading principles. The presented criteria and theoretical framework were validated by participants for this aspect.

4.5.3.2 Other components to be considered in intervention of visual perception

General grading principles- Hierarchical Visual Perceptual Framework and learning theories (Piaget's learning theory)

No changes or additions were recommended for general grading principles and the theoretical framework was validated by participants.

General Intervention principles- Hierarchical Visual Perceptual Framework and learning theories **(Mosey's learning theory)**

No changes or additions were recommended for general intervention principles and the theoretical framework was validated by participants.

Dynamic Systems Theory Model of Visual Perception

The application of the dynamic systems theory to visual perceptual (DSTMVP) intervention was validated by participants and no theory was added or changed to the theoretical framework for the DSTMVP. Participants reported that the concept of the DSTMVP was logical and they agreed it should be included in the intervention criteria.

Visual perceptual requirements for ADHD learners when using graphic material

When considering the components of visual attention and oculomotor treatment the grading principles were accepted without change and the theoretical framework was validated by participants. No items were removed the following additions were recommended.

Guidelines to reduce visual distractibility - it was suggested visual objects that are similar should be grouped together. Todd (1993) supported the suggestion by recommending that items should be organised next to each other if they go together. Schneck (2005) agreed and recommended that objects that belong together are grouped with lines of blocks.

The participants also suggested that clear boundaries with high contrast lines should be used to assist with organization. Todd (1993) agreed and suggested that there should be lines to separate items to give visual boundaries. He said lines will assist with organization and prevent the possibility of skipping lines.

4.5.3.3 Important elements a multi-media intervention programme should contain

The secondary focal question was addressed by considering important elements or theories that could be included in a multi-media intervention programme for the remediation of visual perceptual skills for learners diagnosed with ADHD. The participants validated the theoretical framework and recommended that the following items should be added.

Monitoring of progress and outcomes - the participants recommended that the programme should allow adjustment for speed and difficulty levels as the learners' progress. This was supported by Schneck (2010a) who stated that visual perception requires the maturation and the functioning of the central nervous system, specifically on the cortical structures. Maturational improvements should be observed through increased speed, amount and complexity of visual information that learners can process (Todd, 1993). This criteria was added to the theoretical framework.

The following practical aspects to consider when selecting a computer programme for the remediation of visual perceptual skills were also recommended. These recommendations could not be validated with literature due to a limitation of research in this field, however recommendations but will be considered.

- Each participant of the computer-based intervention should have access to log into their own accounts and the administrator can log into all the accounts.
- It would also be beneficial if the programme is able to score each activity that the participant completes and keep a record of that.

4.5.3.4 Weighting of intervention criteria

The weighting for each subsection supported by literature and theoretical constructs was established by calculating the total for the subsection in relation to the total weighting of intervention criteria (131) as reflected in (Table 4.14 and Table 4.15).

Table 4.14 and 4.15 are a summary of the totals for the intervention criteria checklist as presented in Table 4.10 to 4.13. The computer-based programme with the highest total was the one that was selected.

The weighting for visual memory, visual discrimination, visual spatial relations and visual closure was determined by considering the total for intervention principles and grading principles in relation to the total overall weighting of 131. The weighting for the other sections was determined by considering the total of the section in relation to the overall total of 131. Figure 4.2 illustrates the total weighting percentage of the various visual perceptual components and theories considered.

Visual Memory obtained the highest weighting (19,4%) of the total criteria. The DSTMVP achieved the second highest weighting (15,2%) of the total criteria followed by guidelines when using activity worksheets or graphic material with 13,9%. Visual discrimination received 12,4% weighting of the total score. General principles achieved a weighting of 19.4%. Visual Spatial Relations produced a total weighting score of 6.9%. Feedback and motivation as well as monitoring progress and outcomes got the second lowest weighting of 2.3% of the total score. Instruction and description a well as visual closure obtained the lowest percentage (2,3%) of the total value.

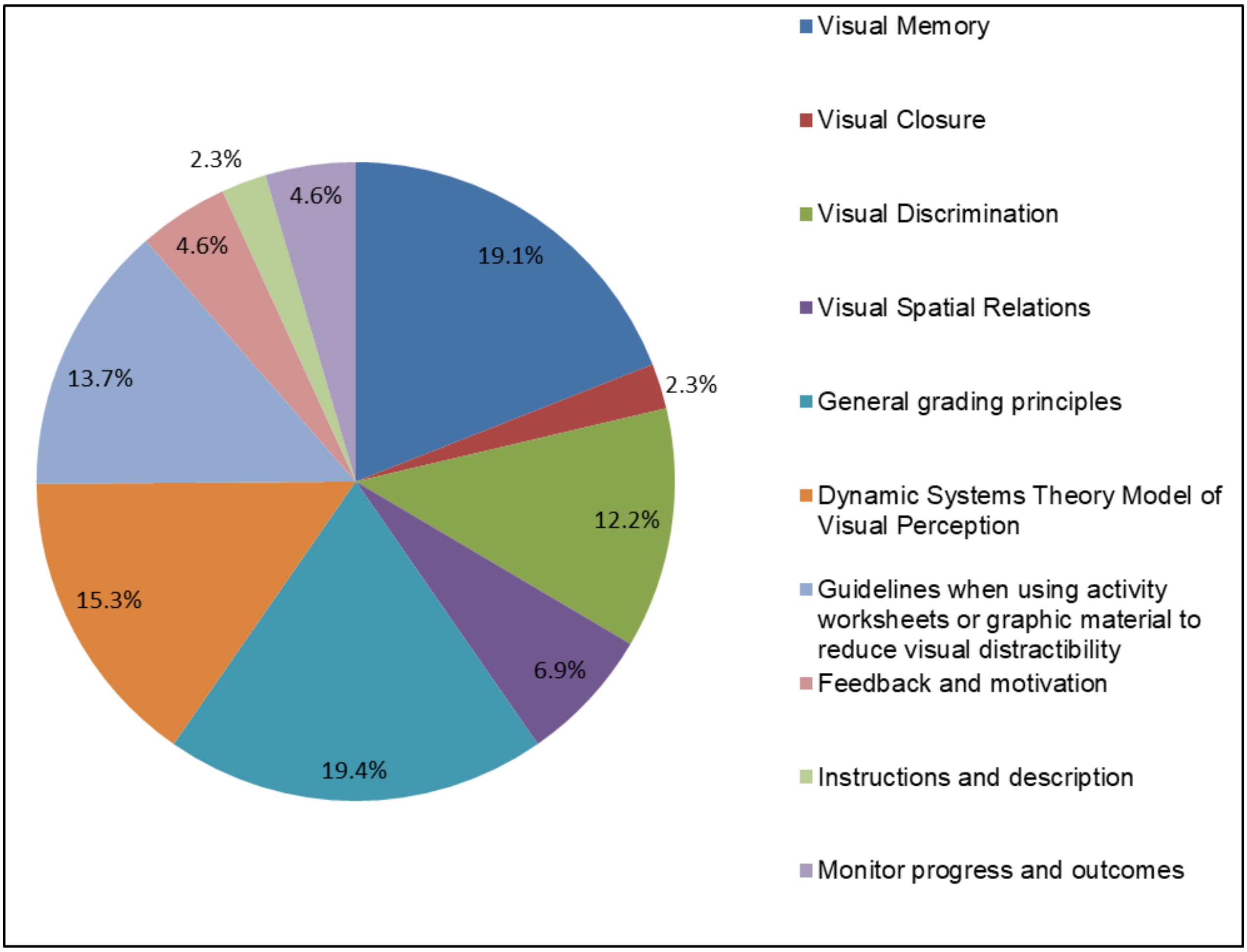


Figure 4.2 Total weighting percentages of the various identified criteria

The recorded weighting for each intervention criterion as was recorded in the nominal group was then used to develop the final intervention criteria checklist (Table 4.10 to 4.13).

4.5.3.5 Final selection of intervention criteria and scoring

The final selection of the intervention criteria in the intervention criteria checklist is presented in Tables 4.10 to 4.13. The weighted criteria for each visual perceptual component are presented for treatment principles and where appropriate grading. The weighted grading for intervention criteria based on visual perceptual theories and cognitive and learning theories, as well as occupational therapy paediatric frames of reference the dynamic systems theory and requirements for computer programmes for learners with ADHD are also presented.

Table 4.10: Intervention criteria checklist with weighting – Visual memory, visual closure, Visual discrimination and visual spatial relations

TREATMENT PRINCIPLE	Weighting	GRADING	Weighting
VISUAL MEMORY			
Maintenance rehearsal or pure repetition can be used to hold information for immediate use (Todd, 1993)	**4**	The time period that participant's has to remember facts or objects should be manipulated (Witthaus, 2002). They should require less time the more advanced they get.	**4**
Visual memory will improve when visual attention, motivation and comprehension is present (Todd, 1993)	**5**	The amount of visual input to recall can gradually increase in relation to skill (Witthaus, 2002).	**3**
Visual memory will improve when it is combined with another sensory system (Todd, 1993). Auditory input can be used during the programme to enhance the visual memory.	**3**	Visual sequences is a grading from recalling single visual items to multiple (Todd, 1993)	**1**
Visual memory can be improved by repetition (Todd, 1993). Similar concepts or activities can be used in the programme.	**2**	The amount of facts or objects that participant has to recall will be increased according to skill (Todd, 1993)	**2**
The participant should be exposed to practicing long term and short term memory (Witthaus, 2002).	**1**		
VISUAL CLOSURE			
Make sure that participant sees the whole first and then the parts for example if the participant has to complete a puzzle to first see the big picture and then complete the puzzle.	**2**		
Make sure the missing part or correct response is indicated for the participant to receive the feedback	**1**		
VISUAL DISCRIMINATION			
Visual stimuli should be simply presented in a clearly organized manner	**1**	Visual discrimination is enhanced with the visual stimuli are presented from general to specific, whole to parts, familiar to unfamiliar and concrete to abstract.	**1**
Activities that allows participants to identify similarities and differences between objects (Witthaus, 2002).	**2**	Participants should initially identify gross similarities/ differences of objects and later on identify smaller similarities/differences (Witthaus, 2002).	**4**
Activities that allows differentiation to take place and address the skills of recognition, matching and sorting(Kramer P and Hinojosa J, 1993).	**4**	Increase the amount of similarities/differences between objects as the learners skill improves (Witthaus, 2002).	**3**
		The learner should be exposed to 3D and 2D activities involving visual discrimination (Witthaus, 2002) (exposure to 3D activities will occur during traditional therapy	**1**
VISUAL SPATIAL RELATIONS			
The participant has to orientate their own body in relation to objects using the following concepts: " on, under next to, behind, in front , inside, above, between, over, near, far"(Witthaus, 2002):270)	**4**		
The participant has to learn to orientate one object to another in relation to words such as on, under, next to, behind, in front of ect (Witthaus, 2002).	**2**		
The participant has to learn to notice the difference in spatial orientation of objects (Witthaus, 2002)	**1**		
Participants will be instructed to visually scan the screen from left to right (Schneck, 2005). Learners with visual spatial problems often choose random starting points, resulting in them missing out on work (Schneck, 2005)	**3**		

Table 4.11: Intervention criteria checklist with weighting – General grading principles according to cognitive and visual perceptual development and the Framework of Hierarchical Development of Visual Perception

GENERAL GRADING PRINCIPLES - **COGNITIVE AND VISUAL PERCEPTUAL DEVELOPMENT**	**Weighting**
Simple to complex Grading from simple to complex should be applied to the programme by grading from one item to two or more. Simple pictures with minimum visual clutter will be used and graded to pictures with more information and visual clutter. Primary colours will be used first followed to secondary colours. Symbols will be graded from a straight vertical line to a circle to a cross, square, horizontal line, triangle and lastly a diamond shape (Schneck, 2010b; Witthaus, 2002).	**5**
Familiar to novel A child develops the ability to relate to objects and to recognise familiar objects in two dimensions when they interact with objects that can be seen, felt and manipulated4. The researcher will therefore divide the program into themes that are familiar to the learners. The learners would have had previous knowledge and multisensory experience with topics presented in the program. Activities will be graded from concrete to abstract by introducing familiar objects first and then grading to unfamiliar. Photographs or realistic drawings will be introduced first followed by abstract pictures. The researcher will first make use of shapes, symbols thereafter letters and words (Schneck, 2010b).	**4**
Personal to worldly Grading from personal to worldly will commence with body concepts followed by shapes, pictures, letters and numbers. Schneck (2010b) suggests that visual perception develops from general to specific, whole to parts, concrete to abstract and familiar to novel.	**2**
General to specific Recognition of objects is often learned within the context of a familiar activity. As experiences with objects increase the learner will begin to group objects that are visually similar into what Piaget calls categories(Todd, 1993; Pulaski, 1971). Shared characteristics or similarities of items are learned when classifying them. As learners become more advanced at classifying items they learn that attention is paid not only to the overall shape but also to items specific characteristics (Kramer P and Hinojosa J, 1993). The ability then develops to analyse the whole against the part (Todd, 1993). The concept of grading from general to specific relates to the grading of simple to complex. A learner has to identify, distinguish and discriminate detail of the visual stimuli when grading takes place from general to specific or from simple to complex. Shapes and pictures with little visual clutter and detail will be graded to pictures with more detail and features.	**3**
Whole to parts In order to understand the relationship of the whole to its parts in visual discrimination it is required not only to recognize whole forms but also to raise awareness of spatial organization and the relationship between components(Todd, 1993)	**1**
GENERAL GRADING OF LEARNING PRINCIPLES - FRAMEWORK OF HIERARCHICAL DEVELOPMENT OF VISUAL PERCEPTION (Mossey 1986)	**Weighting**
Activities should be selected that is age, gender appropriate and reflects a learner’s interest.	**3**
Motivation to engage and complete tasks plays a role in the learning process(Mosey, 1986).	**4**
Learning is enhanced if the child receives positive reinforcement and feedback as consequence of his actions. Trial and error, shaping, and imitation of models are important learning techniques.	**1**
Repetition and practice are important aspects of learning(Mosey, 1986). An element of repetition should be embedded in the programme. It will be useful if the programme can track what activity each participant did last and revises previously successful activities before commencing with new activities.	**2**

Table 4.12: Intervention criteria checklist with weighting – Visual perceptual requirements for ADHD learners when using graphic material

Dynamic Systems Theory Model of Visual Perception (Coté, 2015)					
GOAL	**Weighting**	**ATTENTION AND KNOWLEDGE**	**Weighting**	**RETINAL IMAGE**	**Weighting**
Activities should be goal directed	2	Activities should attract visual attention	2	Recognition of objects to stimulate the foveal vision Application: familiar objects that can be recognised.	2
Goals can occur on different levels	1	Activities should be within the child's frame of reference to allow them to apply previous knowledge	1	Spatial location and movement to stimulate parafoveal vision(Coté, 2015) Application: Animations that can move across the screen. Objects that needs to be dragged over the screen from one space to another.	1
EARLY VISUAL PROCESSES	**Weighting**	**LANGUAGE AND CULTURE**	**Weighting**	**MOTIVATION AND EMOTIONS**	**Weighting**
Activities that involve visual memory should be included.	1	Auditory instructions of the programme should provide instructions in the language of teaching and learning of the learners.	2	A programme should include positive reinforcement that can elicit a good emotional response	1
		Activities should be acceptable and identifiable for all cultures.	1		
TACTILE AND PROPRIOCEPTION	**Weighting**	**POSTURE AND MOVEMENT**	**Weighting**		
Activities should include a tactile component	2	Activities should be presented on a multimedia device that can offer a stable base of support.	2		
Images presented must be in different spatial orientation and sizes.	1	Activities should include elements of movement of images across the screen.	1		
GUIDELINES WHEN USING ACTIVITY WORKSHEETS OR GRAPHIC MATERIAL TO REDUCE VISUAL DISTRACTIBILITY:(Todd, 1999)					
Covering work that is finished or net yet finished may reduce visual distractions(Kurtz, 2006),(Mosey, 1986).			**3**	Lines to separate items and give visual boundaries to assist disorganized children that skips items(Todd, 1993)	**1**
The position of items in the visual array can assist performance. Items that are arranged vertically for comparison are simpler to see that items organized horizontally(Todd, 1993)			**2**	High contrast images should be used that defines boundaries and attracts the eye, it should provide clear input (Todd, 1993).	**6**
Organize items that go together next to each other(Todd, 1993)			**5**	Outlining in heavy lines can attract visual attention to appropriate detail (Todd, 1993)	**1**

Table 4.13: Intervention criteria checklist with weighting – Important elements of a computer programme for the remediation of visual perceptual skills in children diagnosed with ADHD

Feedback and motivation	Weighting	Instructions and description	Weighting	Monitor progress and outcomes	Weighting
Feedback will be given during each activity. A correct response will be indicated by a smiley face and auditory input saying "well done"; a sad face will appear when an incorrect response is entered with auditory input saying "try again". They will also receive a certificate upon completing each week of the programme.	**2**	Instructions should be presented to participants by means of visual and auditory input.	2	The programme should consist of a login system where the participant's personal details such as name, date of birth, age, class, gender and medication should be stored.	3
The level of difficulty will be adapted to the participant's level of skill.	**3**	Participants will get the chance to practice each activity through demonstration before commencing each new activity.	1	Each participant will have access to log into their own accounts and the administrator can log into all the accounts.	1
Participants will receive a score at the end of each session; this will motivate them to improve their own skills.	**1**			The programme should be able to score each activity that the participant completes and keep a record of that. Participant's progress can be tracked by seeing the graphs and scores of participations in each activity	2

4.6 SELECTION OF A COMPUTER PROGRAMME

4.6.1 Introduction

The researcher in collaboration with one expert occupational therapist screened the existing commercially available computer programmes in the South African market which address visual perception using the intervention criteria checklist. No literature or previous research was available on electronic media for the remediation of visual perceptual skills in South Africa. Previous international research reviewed in chapter 2 provided evidence of the value of using multi-media and computer-based intervention with various disabilities for the improvement of visual perceptual skills. Considering suggestions in the previous research, the primary investigator decided on outcome measures to use, intervention periods and duration of interventions. No information regarding selection criteria or treatment principles was available in the literature. Computer-based programmes used in previous research are not available in South Africa and do not have the required technical support in South Africa. Thus, the primary investigator did not access programmes used in previous research for review. The programmes available for selection were also limited due to financial constraints and lack of funding as this research project was self-funded therefore a limited number of programmes could be purchased for review purposes. The researcher therefore did not consider any programmes developed in other countries due to high expense as well as the lack of both English and Afrikaans instructions.

Limited internet access and cost of access in South Africa also had to be considered limiting the feasibility of an internet-based programme. The researcher sourced information on visual perceptual computer-based programmes developed in South Africa from companies who provide software for education and therapy and other occupational therapists. Although demo/ complimentary programmes were requested from companies for the programmes to be reviewed none of the companies were willing to provide the programmes. The limited programmes available in the South African market which included both English and Afrikaans were researched and content information collected on each before making the final purchase. There is no previous research available on the two identified software programmes. The available programmes were reviewed using the intervention criteria checklist and the computer requirements to run them were checked to determine that the computers available for use in Phase 3 could support these programmes.

Each computer programme was evaluated using the evaluation form (Table 4.14 and Table 4.15) developed to reflect the intervention criteria Tables 4.10 to 4.13.

4.6.2 Evaluation procedure

An expert occupational therapist was recruited based on the inclusion criteria provided for the nominal group. One of the participants who attended, the nominal group was selected. She showed interest and knowledge in the intervention of visual perceptual skills using multimedia. She assisted the researcher in the evaluation of the computer-based programmes sourced for the study.

The researcher designed an evaluation form based on the intervention checklist developed in the nominal group (Table 4.14-Table 4.15). The programme was viewed and checked for intervention and grading criterion for each visual perceptual component. If the criterion was present it was scored according to the weighting it received on the intervention criteria checklist. For example, the visual memory component consisted of five intervention criteria for treatment principles and four grading principles. It was rated 1 to 5 for intervention principles and 1 to 4 for grading principles. If all criteria were present in the programme a total of 25 (adding the intervention and grading principles together) was possible. The total for each visual perceptual component was added up to get the final rating for that component. A similar procedure was used for all sections on the intervention checklist reflected on the evaluation form.

Once all sections listed on the evaluation form had been scored these were added up to indicate the final score for that programme. Adding up the total of each subsection determined the programme that had the highest intervention criteria. This process facilitated the selection of the most appropriate computer programme for the remediation of visual perceptual skills in 7-9 year old learners diagnosed with ADHD.

Although a large number of computer-based games which include components of visual perception that include English and Afrikaans are available are none of these have been designed specifically for the remediation of visual perception. The researcher and the expert first reviewed these programmes independently from each other using the evaluation form. Thereafter they went through the intervention criteria checklist again and agreed on all points as to what programme received the highest rating. The programme with the highest rating was selected to be tested in Phase 3 to evaluate effectiveness in remediating visual perceptual dysfunction in learners diagnosed with ADHD.

Games from commercial companies were evaluated. Only three local games designed for educational purposes included visual perception as well as grading for visual perceptual skills. These three local computer programmes were available in English and Afrikaans

4.6.3 Programmes evaluated

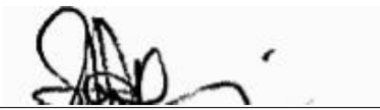
Of the suitable programmes selected it was established that one, *Dina the Dinosaur Educational Software*™, was developed for 4-7 year old children outside the age range for this study and therefore this programme was excluded. The evaluation of the two remaining programmes for use in Phase 3 is presented.

4.6.3.1 *Cami Perceptual Skills Builder™*

Cami Perceptual Skills Builder™ is a well-designed programme. It is a user-friendly programme and easy to operate. The programme is bilingual and instructions are clearly provided visually and auditory. Unfortunately, the programme does not cover all the visual perceptual areas. There were no activities for visual discrimination and visual closure. The programme contained 47% of intervention criteria required for treatment principles and grading of visual memory, visual closure, visual discrimination and spatial relations. There were 72% of general principles identified in the programme. The programme contained 60% of the DSTMVP intervention criteria and 50% of guidelines using activity worksheets of graphic material to reduce visual distractibility.

The computer software evaluation form of the *Cami Perceptual Skills Builder*™ is illustrated in Table 4.14. The *Cami Perceptual Skills Builder*™ scored a total of 74 on the computer software evaluation form. The programme contained 56% of the total intervention criteria required.

Table 4.14: Computer-based evaluation of the *Cami Perceptual Skills Builder™*

<table>
<tr><th colspan="6">COMPUTER SOFTWARE EVALUATION FORM</th></tr>
<tr><td colspan="2">Name of computer software:</td><td colspan="4">Cami Perceptual Skills Builder™</td></tr>
<tr><td colspan="2">Age band of computer software:</td><td colspan="4">4-9 years</td></tr>
<tr><td colspan="2">Languages of computer software:</td><td colspan="4">English/Afrikaans</td></tr>
<tr><td colspan="6">Visual perceptual constructs included in the programme</td></tr>
<tr><td>VD</td><td>VC</td><td>VM</td><td>SR</td><td colspan="2">Visual Attention</td></tr>
<tr><td></td><td></td><td>X</td><td>X</td><td colspan="2">X</td></tr>
<tr><th colspan="6">Total of intervention criteria
(Treatment principles and grading)</th></tr>
<tr><td colspan="4"></td><td>Max</td><td>Score</td></tr>
<tr><td colspan="4">Visual Memory</td><td>25</td><td>16</td></tr>
<tr><td colspan="4">Visual Closure</td><td>3</td><td>0</td></tr>
<tr><td colspan="4">Visual Discrimination</td><td>16</td><td>0</td></tr>
<tr><td colspan="4">Visual Spatial Relations</td><td>9</td><td>6</td></tr>
<tr><th colspan="6">Other components to be considered in intervention criteria for visual perception in learners diagnosed with ADHD</th></tr>
<tr><th colspan="6">General principles</th></tr>
<tr><td colspan="4">Cognitive and visual perceptual development</td><td>15</td><td>12</td></tr>
<tr><td colspan="4">Learning principles - framework of hierarchical development of visual perception</td><td>10</td><td>6</td></tr>
<tr><th colspan="6">Visual perceptual requirements for ADHD learners when using graphic material</th></tr>
<tr><th colspan="6">Dynamic Systems Theory Model of Visual Perception</th></tr>
<tr><td colspan="4">Goal</td><td>3</td><td>2</td></tr>
<tr><td colspan="4">Attention and Knowledge</td><td>3</td><td>1</td></tr>
<tr><td colspan="4">Retinal Image</td><td>3</td><td>3</td></tr>
<tr><td colspan="4">Early Visual Processes</td><td>1</td><td>1</td></tr>
<tr><td colspan="4">Tactile and Proprioception</td><td>3</td><td>1</td></tr>
<tr><td colspan="4">Language and Culture</td><td>3</td><td>2</td></tr>
<tr><td colspan="4">Posture and Movement</td><td>3</td><td>1</td></tr>
<tr><td colspan="4">Motivation and Emotions</td><td>1</td><td>1</td></tr>
<tr><td colspan="4">Guidelines when using activity worksheets or graphic material to reduce visual distractibility</td><td>18</td><td>8</td></tr>
<tr><th colspan="6">Important elements of a computer programme for the remediation of visual perceptual skills in children diagnosed with ADHD</th></tr>
<tr><td colspan="4">Feedback and Motivation</td><td>6</td><td>6</td></tr>
<tr><td colspan="4">Instructions and Description</td><td>3</td><td>2</td></tr>
<tr><td colspan="4">Monitor Progress and Outcomes</td><td>6</td><td>6</td></tr>
<tr><td colspan="4">Total score</td><td>131</td><td>74</td></tr>
<tr><td colspan="3">Software recommended</td><td colspan="3">Software not recommended</td></tr>
<tr><td colspan="3"></td><td colspan="3">√</td></tr>
<tr><td colspan="6">Comment:</td></tr>
<tr><td colspan="6">Grading can improve. Visual discrimination and visual closure not included.</td></tr>
<tr><td colspan="3">Signature researcher</td><td colspan="3">Signature expert in the field</td></tr>
<tr><td colspan="3"></td><td colspan="3"></td></tr>
</table>

4.6.3.2 *Sea World Adventures™*

Sea World Adventures™ perceptual programme is a comprehensive programme that includes all areas of visual perception. Table 4.15 illustrates the rating of the programme according to the intervention criteria on the computer software evaluation form. A total of 88% of the treatment and grading principles were present for visual memory, visual closure, visual discrimination and visual spatial relations. In the general principle section 92% of the intervention criteria were present. This programme met all the criteria set out according to the Dynamic Systems Theory Model of Visual Perception (100%). A limitation to the programme was the criteria according to the guidelines when using activity worksheets or graphic material to reduce visual distractibility. The programme only complied with 44% of these intervention criteria. The programme contained 80% of criteria identified in the important elements of a computer programme for the remediation of visual perceptual skills in children diagnosed with ADHD. The programme is bi-lingual, user-friendly, well graded and follows treatment principles of visual perceptual intervention. Each activity has different levels of difficulty and it is visually visible for the learner. The voice in the programme is friendly and encouraging when the child does not get it right. There are stars in the bottom corner that shows the learners progress to the next level.

This programme scored a total of 111 (84%) on the evaluation of the intervention criteria. The *Sea World Adventures™* programme therefore obtained the highest score. *Sea World Adventures™* was therefore the programme that was selected to test the effectiveness of computer-based intervention with 7-9 year old learners diagnosed with ADHD.

Operational requirements of the programme

The minimum system requirements are a 500MHz processor with Microsoft Windows 2000 SP4 or XP. A 256MB RAM hard drive is required and 800X600 16 bit display. A CD ROM and Sound are also requirements.

Background and History of the programme

Sea World Adventures™ perceptual programme was developed by Linda Pauwels she has an Honours degree in Educational Psychology. The programme was published in 2006 but is frequently updated by Compu Iq. There is very good IT support for *Sea World Adventures*™ perceptual programme, Compu Iq does their IT support and they have a call centre with knowledgeable support staff.

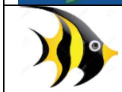
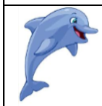
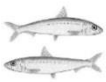
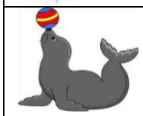
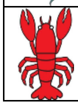
Table 4.15*: Sea Word Adventures*™ programme evaluation of intervention criteria

COMPUTER SOFTWARE EVALUATION FORM				
Name of computer software:	*Sea World Adventures*™			
Age band of computer software:	4-9 years			
Languages of computer software:	English/Afrikaans			
Visual perceptual constructs included in the programme				
VD	**VC**	**VM**	**SR**	**Visual Attention**
X	X	X	X	X
Total of intervention criteria (Treatment principles and grading)				
			Max	**Score**
Visual Memory			**25**	20
Visual Closure			**3**	3
Visual Discrimination			**16**	15
Visual Spatial Relations			**9**	9
Other components to be considered in intervention criteria for visual perception in learners diagnosed with ADHD				
General principles				
Cognitive and visual perceptual development			**15**	13
Learning principles - framework of hierarchical development of visual perception			**10**	10
Visual perceptual requirements for ADHD learners when using graphic material				
Dynamic Systems Theory Model of Visual Perception				
Goal			**3**	3
Attention and Knowledge			**3**	3
Retinal Image			**3**	3
Early Visual Processes			**1**	1
Tactile and Proprioception			**3**	3
Language and Culture			**3**	3
Posture and Movement			**3**	3
Motivation and Emotions			**1**	1
Guidelines when using activity worksheets or graphic material to reduce visual distractibility			**18**	18
Important elements of a computer programme for the remediation of visual perceptual skills in children diagnosed with ADHD				
Feedback and Motivation			**6**	6
Instructions and Description			**3**	3
Monitor Progress and Outcomes			**6**	3
Total score			**131**	111
Software recommended		**Software not recommended**		
√				
Comment:				
Software is theme based and user-friendly. A variety of activities are included. Good integration of various visual perceptual constructs. Grading, motivation and DSTMVP theories very well incorporated.				
Signature researcher		**Signature expert in the field**		
				

Description of the Sea World Adventures™ perceptual programme

The *Sea World Adventures™* perceptual programme consists of 11 sea animals that have different activities and remediate various skills (Table 4.16). The *Sea World Adventures™* perceptual programme did not include specific exercises for visual tracking therefore that was done by the therapist prior to intervention. There was however animations that contained movement during the activities of the programme that stimulated ocular-motor responses.

Table 4.16: Description of the activities in the Sea World Adventures™ programme.

SEA ANIMAL	SKILLS THAT ARE DEVELOPED:
	**TURTLE:** Visual memory, Form recognition, Consistency & distinction, Colour recognition & distinction, Sizes proportions; Auditory memory, Vocabulary.
	**ANGEL FISH:** Visual discrimination, Memory, Same & Different, Figure ground, Form recognition, Association, Colour recognition, Concentration, Succession, Consistency, Number recognition, Hand-eye Co-ordination, Reasoning, Sorting, Grouping , Alphabet, Letter discrimination.
	**DOLPHIN:** Visual discrimination, Memory, Same & Different, Figure-ground, Form recognition; Mathematical concepts; Concentration; Number Concepts; Classification; Problem solving; Alphabet; Letter discrimination.
	**SHARK**: Visual discrimination; Analysis& synthesis; Form recognition; 3-D forms; Association; Succession; Consistency; Pattern completion; Sequencing; Number concepts; Hand-eye co-ordination; Reasoning; Sorting; Grouping; Common knowledge.
	**SARDINES:** Sizes & proportions; Auditory memory; Concentration; Spatial orientation; Hand-eye Co-ordination; Reasoning; Grouping; Alphabet; Problem solving.
	**Jelly Fish:** Form recognition, spatial concepts Dimensional forms; Colour recognition; Sizes & proportions; Classification; Sorting; Grouping.
	**SEAL:** Visual discrimination; Visual Closure; Analysis & synthesis; Form distinction; Colour recognition; Mathematical concepts; Differences and similarities; Sequencing; Pattern completion; Number concepts; Spatial orientation; Directionality; Hand eye Coordination; Reasoning; Grouping; Common knowledge; VMI
	**WHALE:** Visual memory; Form recognition; Dimensional forms; Colour recognition; Mathematical concepts; Association; Concentration; Number concepts; Reasoning; Problem Solving.
	**SEAHORSE:** Form recognition; Consistency; Colour recognition &; Number recognition; Hand- eye Co-ordination.
	**COLOURFUL FISH**: Visual closure; Form recognition; Colour recognition; Pattern completion; Number concepts; Hand-eye co-ordination; Grouping; Vocabulary; Letter discrimination.
	**KILLER WHALE:** Mathematical concepts; Successions; Number concepts; Hand-eye Co-ordination; Reasoning; Sorting; Grouping; Vocabulary& Alphabet; Language; Letter discrimination; Common Knowledge.
	**STING RAY:** Classification; Spatial concepts; Form and colour recognition.
	**LOBSTER:** Visual closure; Spatial relations; Following of directions; Colour concepts; shape concepts.

The next section will illustrate how the intervention and grading principles rated as important in the nominal group were incorporated in the selected programme. This section will only provide selected examples of how principles were incorporated. Each example had various other similar activities included.

Motivation and Feedback

Figure 4.3 illustrates how motivational aspects were incorporated in the *Sea World Adventures*™ programme. The yellow octopus on the right side is the game guide that provides auditory instructions and feedback. The octopus is always found in the same location therefore providing consistency and familiarity. The facial expression of the octopus also indicates if it was a correct or incorrect response. On the top right side there is a rectangle bar, once the bar is completely green the participant gets a colour in a star. If a participant receives a colour in their star a green smiling starfish is displayed on the screen as illustrated on the right screenshot. Once all the stars received their colours participants can proceed to the next level by clicking on the pipe on the bottom right side of the screen. The length of the pipe indicates the level of difficulty with the shortest pipes being the easiest and the tallest one the most difficult.

Figure 4.3: Motivation presented in the *Sea World Adventures*™ programme

Visual Memory

Visual memory was incorporated in the turtle, angelfish, dolphin, sardines, lobster, whales, jelly fish, sea horse and killer whale (Appendix Q) activities of the *Sea World Adventures*™ programme. Figure 4.3 illustrates four screenshots (different levels) of the angelfish activity. Visual attention is attracted in the angelfish activity by the animation of the octopus, variation of colours and objects. Visual attention and motivation are maintained in this activity by voice prompts by the octopus (right hand side of each screenshot). Additionally, visual attention was maintained by the various levels that were indicated visually on the right bottom corner and the progress stars for each level in the top right corner. Grading principles that were present in Figure 4.4 include simple to complex grading. Activities are graded from familiar objects to shapes thereafter shapes and letters and finally words. Familiar to novel grading is also illustrated as observed in the third frame where a combination of symbols and letters are used. This grading plays an important role because it is the transition from basic concepts to literacy.

Figure 4.4: Angel fish activity in the *Sea World Adventures*™ programme

The length of time this visual image was present for retention was also adjusted according to the level of skill. Figure 4.5 illustrates an example of the sea horse activity, how a visual timer can be used in an activity to assist with enhancement of skills (visual timer present in bottom corner of green block).

Figure 4.5: Sea horse activity of the *Sea World Adventures*™ programme that illustrates the visual timer

The sardine activity (Figure 4.6) illustrates how multi-sensory systems are utilized for the remediation of visual memory. The participant has to press the green button then the circles flips around playing a sound and revealing a hidden picture. The participant then has to remember in what sequence the circles is revealed and recall it by selecting the sequence.

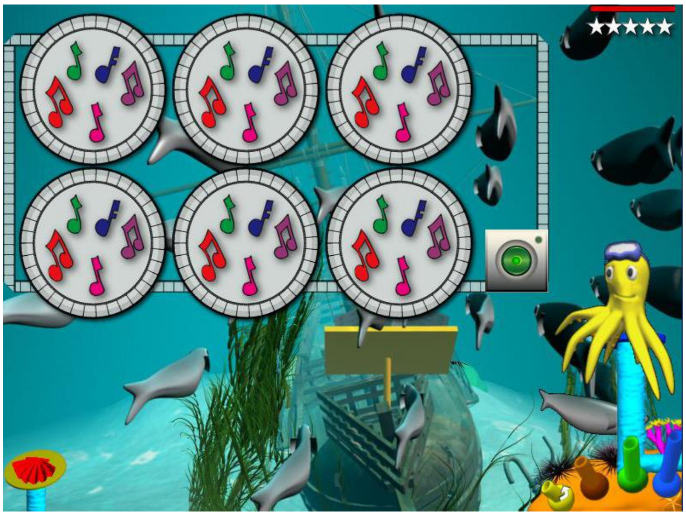


Figure 4.6: Sardine activity of the *Sea Word Adventures*™ programme

Visual Closure

Visual closure was incorporated in the angelfish, dolphin, lobster, seal, colour fish and jelly fish activities (Appendix Q). Figure 4.7 illustrates two screenshots of the intervention principle of considering the whole first and then the parts. Participants have to complete a shape picture but first the whole picture is displayed for a few seconds as illustrated on the left side, thereafter they receive the individual shapes and has to complete the picture as indicated on the right side. The example of how to build the shape picture is present throughout the activity therefore, not relying on visual memory and facilitating remediation of visual closure.

Figure 4.7: Lobster activity of the *Sea World Adventures*™ programme illustrating whole to parts intervention principle

Figure 4.8 illustrates two screenshots of the simple to complex grading principle in the lobster activity. The activity on the left is one of initial activities requiring only two parts to complete as a whole. The activity on the right is an upgraded activity requiring more complex skills with a variety of shapes to construct a shape picture of an identifiable item (train).

Figure 4.8: Lobster activity of the *Sea World Adventures*™ programme illustrating the simple to complex grading principle

Figure 4.8 illustrates how the simple to complex grading was applied to the puzzle activity of the lobster game. Initially a simple four piece puzzle was introduced followed by a more difficult nine piece puzzle thereafter the 16 piece puzzle and finally 30 piece puzzles. There are various designs available in each of the different levels. Familiar to novel grading was also applied with the lobster puzzle activity by using the same pictures in each level but adjusting the complexity.

Figure 4.9: Lobster activity of the Se*a World Adventures*™ programme illustrating simple to complex grading in puzzles.

The colour fish activity (Figure 4.10) is a more advanced example of visual closure intervention. This activity allows the participant to envision what the whole is and by completing the parts they see the whole. After completing the picture, the colour fish assists in colouring in the picture, reinforcing the whole.

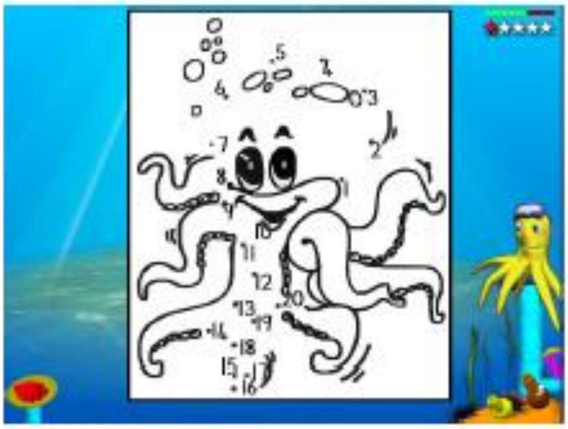


Figure 4.10: Colour fish activity of the *Sea World Adventures*™ programme

Visual Discrimination

Visual discrimination was incorporated in activities of the turtle, angel fish, dolphin, shark, lobster, manta ray, seal, whale, seahorse, jelly fish and killer whale. Figure 4.10 illustrates an example of matching activities. On the left side the participants have to match the picture on the bottom with a similar one above it. The complexity and amount of differences increases as illustrated in the screenshot on the right.

Figure 4.11: Seal activity of the *Sea World Adventures*™ programme illustrating matching

Figure 4.12 illustrates various levels of the shark game. This game requires matching and sorting. The simple to complex grading is displayed as the activity is graded from matching and sorting symbols to numbers and finally letters. The letters and numbers are in a user friendly font that participants can associate with.

Figure 4.12: Shark activity of the *Sea World Adventures*™ programme

Figure 4.13 illustrates an activity from the dolphin game where participants are expected to identify similarities and differences. The number of differences to be found is indicated on the bottom, middle of the page under the binocular sign. It has been found that this was also a motivating aspect for participants to reduce the number of differences when finding a new one.

Figure 4.13: Dolphin activity of the *Sea World Adventures*™ programme illustrating similarities and differences

Figure 4.14 illustrates an activity from the dolphin game of the *Sea World Adventures*™ programme. In this activity literacy skills are used to match similarities and differences. This activity is the most complex activity of the dolphin game and requires visual discrimination, visual memory, spatial orientation and eye hand coordination. Participants are required to select the letter sequence that appears in the shell at the bottom. Underneath the letter sequence is a number that indicates how many matches of the sequence is required. Indicating the number is plays a positive role in motivation and improves learning.

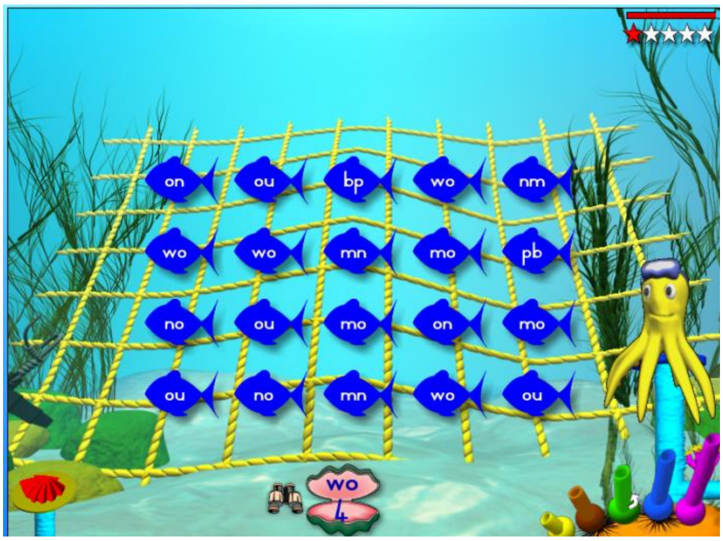


Figure 4.14: Dolphin activity of the *Sea World Adventures*™ programme illustrating a more complex activity involving literacy

Visual Spatial Relations

Visual Spatial Relations was incorporated in activities of the sting ray, lobster, jelly fish, turtle and seal. Figure 4.15 illustrates the initial activity of the jelly fish game. During this activity the octopus (game guide) introduces each object as well as the spatial location for example dolphin top left corner followed with the icon going to that location. Other instructions include angle fish top right corner, crab bottom left corner, pink fish bottom right corner, shark in the middle of the page and the cup under the table. The use of terminology of a spatial nature with the reinforcement of the visual image ensures better comprehension of spatial orientation

Figure 4.15: Initial grading of the jelly fish activity of the *Sea World Adventure*™ programme.

Figure 4.16 illustrates how basic directionality is introduced in level three. This is an important skill to master before more complex activities are introduced.

Figure 4.16: Example of directionality in the jelly fish activity of the *Sea World Adventures*™ programme.

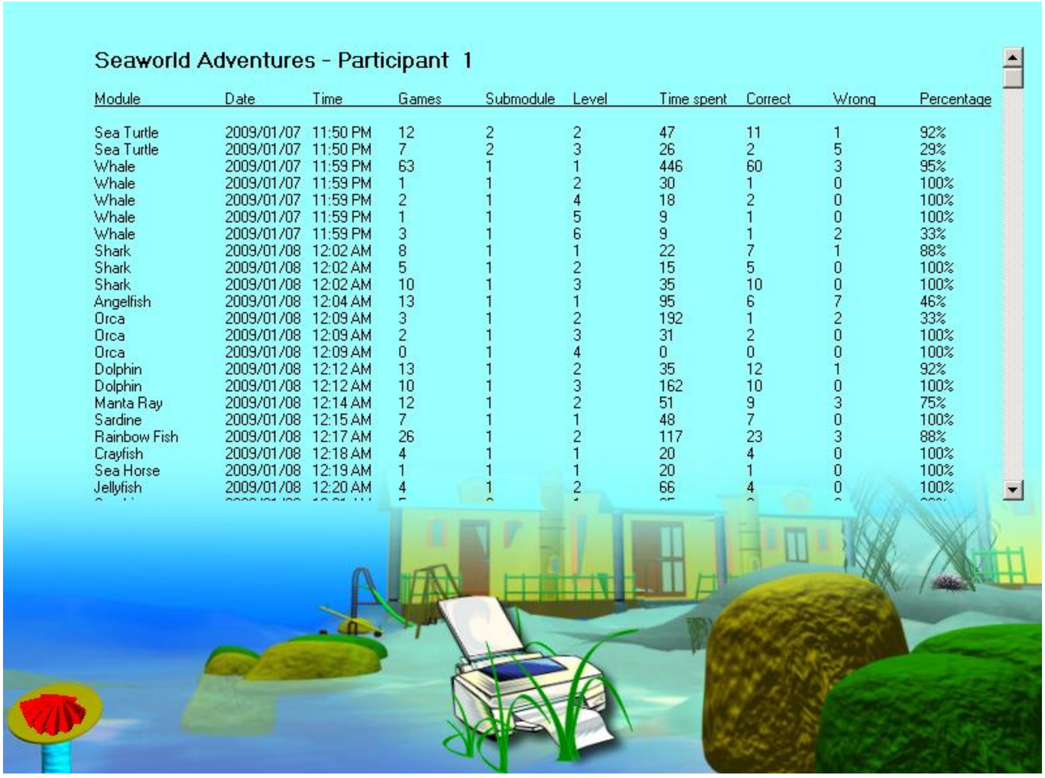
Figure 4.17 illustrates one of the elementary activities in the jelly fish game. Participants are required to move the coloured cylinders to the same spatial location as the example on the left. They are required to move the mouse pointer on the touchpad to the coloured cylinder they want to select and then click and drag it to the correct location.

Figure 4.17: Fourth grading activity in the jelly fish activity of the *Sea World Adventures*™ programme.

Figure 4.18 illustrates the more advanced grading of the jelly fish game. In the first frame, second block the participant is initially required to only connect the dot using one line. This is to ensure that the participant understands the instruction and achieves success. The complexity of the lines increases. In the second frame (more advanced level) the participant is required to complete the mirror image of the picture by connecting the dots with lines. The third frame illustrates the most difficult level of this game. The participant has to complete the mirror image of the picture without dots and using the blocks as a guide. Visual closure and visual discrimination skills are also required to successfully complete these activities.

Figure 4,19: More advance grading of the jelly fish activity of the *Sea World Adventure*™ programme.

Figure 4.20 provides an example of the reporting and scoring of the *Sea World Adventures™* programme. This report gives an overview analysis to direct intervention. The report can also be printed out and participants will have the opportunity to show it to parents or teachers.



Seaworld Adventures - Participant 1

Module	Date	Time	Games	Submodule	Level	Time spent	Correct	Wrong	Percentage
Sea Turtle	2009/01/07	11:50 PM	12	2	2	47	11	1	92%
Sea Turtle	2009/01/07	11:50 PM	7	2	3	26	2	5	29%
Whale	2009/01/07	11:59 PM	63	1	1	446	60	3	95%
Whale	2009/01/07	11:59 PM	1	1	2	30	1	0	100%
Whale	2009/01/07	11:59 PM	2	1	4	18	2	0	100%
Whale	2009/01/07	11:59 PM	1	1	5	9	1	0	100%
Whale	2009/01/07	11:59 PM	3	1	6	9	1	2	33%
Shark	2009/01/08	12:02 AM	8	1	1	22	7	1	88%
Shark	2009/01/08	12:02 AM	5	1	2	15	5	0	100%
Shark	2009/01/08	12:02 AM	10	1	3	35	10	0	100%
Angelfish	2009/01/08	12:04 AM	13	1	1	95	6	7	46%
Orca	2009/01/08	12:09 AM	3	1	2	192	1	2	33%
Orca	2009/01/08	12:09 AM	2	1	3	31	2	0	100%
Orca	2009/01/08	12:09 AM	0	1	4	0	0	0	100%
Dolphin	2009/01/08	12:12 AM	13	1	2	35	12	1	92%
Dolphin	2009/01/08	12:12 AM	10	1	3	162	10	0	100%
Manta Ray	2009/01/08	12:14 AM	12	1	2	51	9	3	75%
Sardine	2009/01/08	12:15 AM	7	1	1	48	7	0	100%
Rainbow Fish	2009/01/08	12:17 AM	26	1	2	117	23	3	88%
Crayfish	2009/01/08	12:18 AM	4	1	1	20	4	0	100%
Sea Horse	2009/01/08	12:19 AM	1	1	1	20	1	0	100%
Jellyfish	2009/01/08	12:20 AM	4	1	2	66	4	0	100%

Figure 4.20: Reporting and scoring of the *Sea World Adventures™* programme

4.7 SUMMARY

The intervention of visual perceptual skills is a complex process that incorporates interrelated concepts and clinical reasoning skills. It is essential to plan intervention and select appropriate tools for intervention to obtain a desired effect. Collaborative approaches with colleagues were used in validating and assisting with the reliability of intervention plans. The intervention criteria were established during the NGT and each criterion was allocated a weighting in order of importance. The computer software evaluation form assisted the researcher and expert to evaluate each computer programme according to the intervention criteria. The *Sea World Adventures*™ programme was selected and contained 84% of the intervention criteria. Intervention criteria assist clinicians with the fidelity of selecting a sound tool for intervention.

CHAPTER 5
PHASE 3 - USE OF TECHNOLOGY IN TREATING VISUAL PERCEPTION

"Everybody is a genius but if you judge a fish on its ability to climb a tree it will live its whole life believing it is stupid"
-Albert Einstein

5.1 INTRODUCTION

This chapter will evaluate the effectiveness of computer-based intervention on the visual perceptual and academic functioning of 7 to 9 year old learners diagnosed with ADHD. Evidence-based practice is essential within the clinical setting to guide clinicians in providing quality services and to make sound decisions based on scientific evidence (Case-Smith, 2015). The first point of discussion is the research problem and objectives, thereafter the selection of research design, sampling and research procedure will be discussed. Data collection, ethical consideration, results and discussion will then conclude.

5.2 RESEARCH PROBLEM AND OBJECTIVES

5.2.1 Statement of the problem

There is limited research evidence available as to whether a computer-based programme will have an impact on the academic and visual perceptual functioning of learners diagnosed with ADHD. Previous research recommended that the efficacy for computer-based intervention should be researched for children with attentional difficulties (Cardona et al., 2000).

5.2.2 Aim

To evaluate the effectiveness of computer-based intervention on the visual perceptual dysfunction and academic functioning in 7 to 9 year old learners diagnosed with ADHD.

5.2.3 Objectives

- To determine the change in visual perceptual functioning on standardised tests of visual perception for the computer-based intervention and routine intervention, and routine intervention only, for 7 to 9 year old learners diagnosed with ADHD.

- To determine the change in academic functioning on a scholastic assessment of the computer-based intervention and routine intervention, and routine intervention only, for 7 to 9 year old learners diagnosed with ADHD.

- To evaluate the behaviour and involvement of the participants when receiving the computer-based visual perceptual intervention

5.2.4 Null Hypotheses Ho

The visual perceptual skills of 7 to 9 year old learners diagnosed with ADHD will not improve significantly by using a computer-based intervention combined with routine intervention when compared to routine intervention only.

The scores for reading and mathematics of 7 to 9 year old learners diagnosed with ADHD will not improve significantly by using a computer-based intervention combined with routine intervention when compared to routine intervention only.

5.2.5 Alternative Hypotheses H

The visual perceptual skills of 7 to 9 year old learners diagnosed with ADHD will improve significantly by using a computer-based visual perception intervention combined with routine intervention when compared to routine intervention only.

The scores for reading and mathematics of 7 to 9 year old learners diagnosed with ADHD will improve significantly by using a computer-based visual perception intervention combined with routine intervention when compared to routine intervention only.

5.3 RESEARCH DESIGN

A longitudinal crossover research design, which is a repeated measurement design, was employed. Participants were divided into two groups randomly assigned to either Group 1 or Group 2. Each participant received a sequence of interventions during different time periods (Piantadosi, 2005). Over two intervention periods, each group received a routine intervention (intervention B). An added intervention (computer-based intervention) was provided (intervention A). Group 1 received the intervention A first followed by Group 2. The advantages of this research design were that each participant served as their own control and secondly, fewer participants were required to achieve a similar level of statistical power in comparison to a parallel design (Piantadosi, 2005). This controlled variability, where the measured effect of intervention was the difference in individual participants (Griel et al., 2008). A 2 x 2-crossover design was employed in the study, with two intervention periods, two sequences of intervention, with the sequence AB and BA. The participants were allocated to a sequence of interventions (intervention A and B) with the purpose of studying the between group results of the treatment approaches (Table 5.1).

Table 5.1: 2 x 2-crossover research design

2x2-Crossover Design	Period 1	Period 2
Group 1 (Sequence AB)	A	B
Group 2 (Sequence BA)	B	A

Figure 5.1 illustrates the research process. The crossover research design allowed the participants to be exposed to all treatments, resulting in fair and equal opportunities for all and ensuring ethical standards were met. The impact that external variables might have had on the study was therefore minimised by comparing the results of Group 1 and 2. Possible disadvantages of the crossover research design were carryover effect that can take place from one intervention period to the other (Piantadosi, 2005). A possible solution to diminish the carryover effect was to implement a washout period, or a time between intervention periods where no treatment is received (Piantadosi, 2005). The washout period took place in the school holiday.

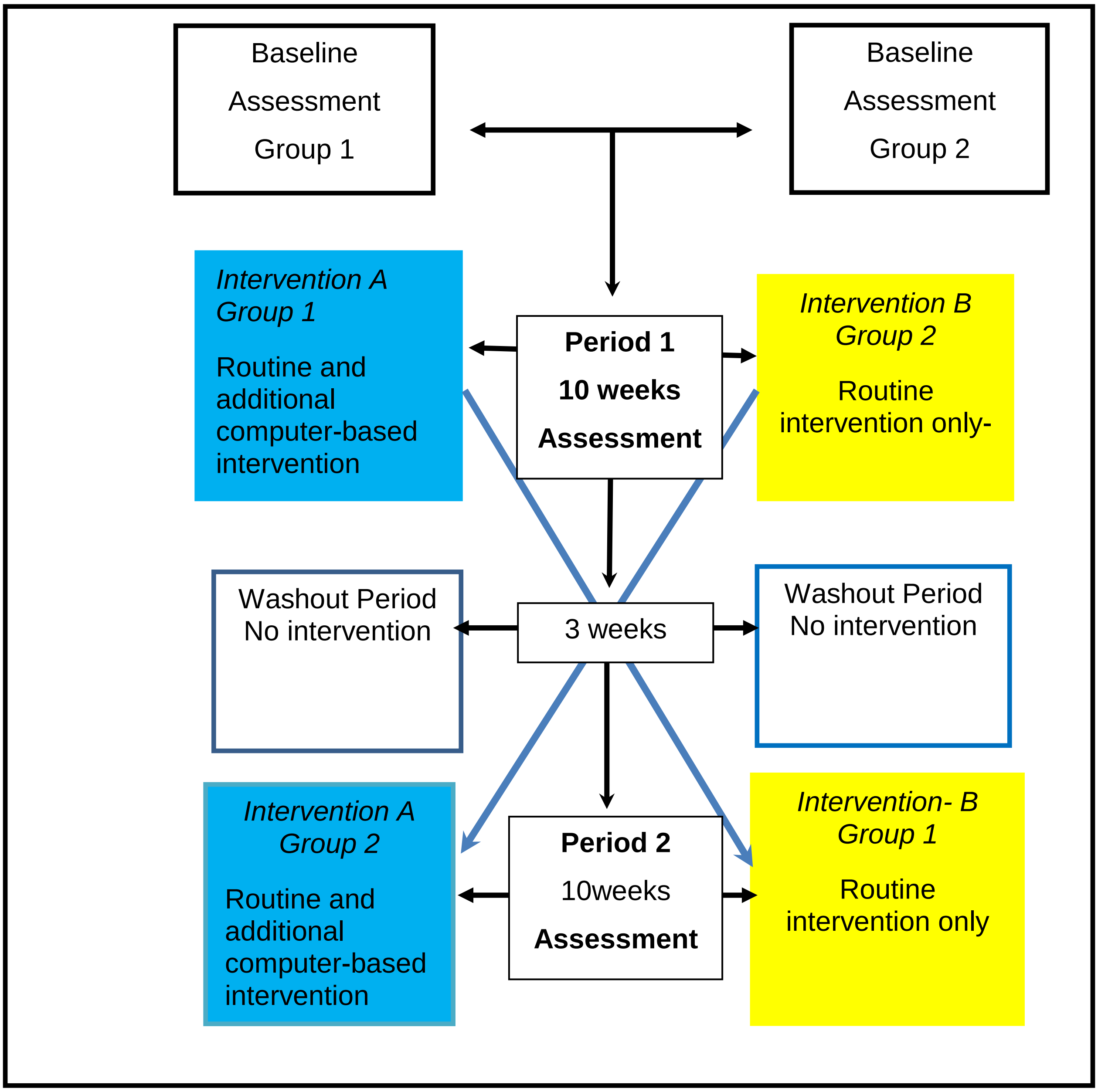


Figure 5.1: Research process of Phase 3

5.4 RESEARCH SETTING AND SAMPLING

The research setting was a Special Educational Needs School (LSEN) within the government sector of Gauteng. Learners who attend an LSEN school do not meet the demands of mainstream education and have barriers to learning that requires remediation. The majority of learners within the research setting had been diagnosed with ADHD and was receiving educational support using a multi-disciplinary team approach. Most of the learners in LSEN schools receive occupational therapy and speech therapy intervention to assist in remediating their barriers to learning. The language of learning and teaching is English and Afrikaans. It was therefore a requirement of the computer programme used for intervention in this part of the study that instructions were provided in both languages.

5.4.1 Sampling

Non-probability sampling methods were employed based on the availability of learners in the foundation phase at the school (Kielhofner, 2006). Purposive sampling was utilised based on the pre-determined inclusion and exclusion criteria and due to the small number of suitable learners, total population sampling was also used to ensure the greatest degree of representation was achieved (Kielhofner, 2006). Therefore, all the learners at the school, within the 7 to 9 years age range (Gr 1-3) with ADHD attending the school, who met the inclusion criteria, were invited to participate in the study (Kielhofner, 2006).

The study population included 54 learners whose parents gave informed consent. Two learners did not give assent to participate so their parents were informed that they would not be included in the study. One learner had a change of medication during the study period and another was frequently absent, so the results of these two learners were not included in the statistical analysis. Due to ethical and social responsibilities, they both completed all intervention programmes.

The final sample of 50 participants was exposed to both treatment conditions. Participants were randomly assigned to either Group 1 (n=25) or Group 2 (n=25). Simple random sampling was used to allocate subjects to Group 1 and 2 using a random number generator. This sampling method allows each constituent in the population to have an equal chance of being in either group (Kielhofner, 2006).

5.4.1.1 Sample size

Previous research using the TVPS-3 indicated that a sample size of 4 is required if a difference of 18.47 points is to be found, with a standard deviation of 12.22 on the TVPS-3 assessment to allow significance at 0.05 at the power of 80% (James et al. (2015); Chen et al., 201). A sample of 45 was required to determine significance difference set at 0.05 at the power of 80%, based on a difference of 5 points on the Beery VMI. The final sample size of 50 participants was therefore adequate for statistical analysis, with a significance level set at 0.05 for both standardised assessments used in this study.

5.4.1.2 Inclusion and exclusion criteria

Learners using medication was not excluded from the study in order to provide a real-life context. However, in the inclusion criteria measures was put in place to ensure that medication is administered regularly in order not to be a limitation to the study.

Inclusion criteria:

- Learners diagnosed with ADHD by a neurologist, and seen by a neurologist within the past 3 months.
- Learners who had been currently receiving occupational and speech therapy for a minimum of one month.
- For those learners who receive medication for ADHD – that they receive it from the school nurse (in the morning) to ensure they are taking their medication during the study period.
- Learners who scored between below -1 SD on the TVPS-3.
- Learners whose parents returned signed informed consent forms and who gave signed assent to participate.

Exclusion criteria:

- Learners with visual impairment not corrected with glasses and/or hearing impairments.

5.4.2 Dependent variables

Change in visual perceptual and academic functioning was the dependent variable.

5.4.3 Independent variables

A 10-week intervention programme using the selected computer programme was the independent variable.

5.5 RESEARCH INSTRUMENTS

5.5.1 Demographic Questionnaire (Appendix K)

This questionnaire that the researcher compiled contained information of participant's age, gender, diagnosis and medication. The questionnaire also had questions to be completed by the parents that described their children's electronic media habits; it was important to establish the level of exposure participants had to electronic devices prior to the study. This information assisted the researcher in planning intervention, selecting the most relevant treatment and establishing the level of anticipated competency. Prior exposure could also influence the effectiveness of computer-based intervention due to either the habituation of sensory and cognitive responses or stimulation thereof.

5.5.2 Tests of visual perception used in the study

Standardised tests of visual perception and visual motor integration were used in the study. These assessments have been shown to be valid for South African children in the foundation phase (Grade 1- Grade 3) attending an urban LSEN school. The results for various visual perceptual tests in the research by Harris (2017) indicated that the standardised tests commonly used in LSEN schools in Gauteng cannot be used interchangeably as the assessments do not evaluate the same aspects of visual perceptual and visual motor skills. Therefore, two assessments of visual perception and visual motor skills were used in this study

5.5.2.1 Test of Visual Perceptual Skills (TVPS 3) (Appendix M)

The TVPS 3 is a motor free assessment that evaluates seven visual perceptual constructs: visual discrimination, visual memory, visual sequential memory, visual-spatial relationships, form constancy, figure ground and visual closure. The subtests have been grouped and classified into four index score categories: Overall, Basic Processes, Sequencing and Complex Processing. Overall index score consists of the total of the scaled scores of subtests. Basic process consists of the scaled scores of visual discrimination, visual memory, spatial relationships, form constancy and sequential memory. Sequential index scores subtests form the sequential memory subtest. Complex processes include higher cognitive skills and consist of the figure ground and visual closure subtests. Composite scores were determined based on cluster analysis and provides meaningful insight in comparison of associated skills.

This assessment is designed for use with learners aged 4 years and 0 months to 18 years. The test is conducted individually by showing the participant test plates of black and white line drawings that contain the various visual perceptual constructs. Participants are required to respond by showing (pointing) or giving the correct answer verbally. The test takes approximate 30 to 40 minutes to administer. Each subtest contains two example test plates at the beginning of the test, followed by 16 items arranged in order of difficulty. Raw scores are recorded on the record form and then converted to scaled scores and percentile ranks. Overall score and indices are derived from the sum of scaled scores and converted to standard scores. There is also an option to convert score to age equivalent norms (Martin 2006).

The assessment has good internal consistency and criterion related validity. The entire scale has a Cronbach’s α of 0.96. Construct validity has been shown with a significant correlation between the total of TVPS-3 and the total of Motor-Free Visual Perception Test, Third Edition (MVPT-3)) $r=0.79$, $p<0.01$)(Brown T et al., 2012).

5.5.2.2 Beery Buktenica Developmental Test of Visual Motor Integration (VMI) 6^{th} ed (Appendix N)

The purpose of the Beery VMI-6 test is to assess the integration of visual perception and motor action. The Beery VMI test consists of a visual motor intergradation (VMI), assessment and two supplemental tests for visual perception and motor coordination. The assessment is standardised and can be administered individually or in groups from age 2 years up to adults.

The Beery VMI-6 test is administered in three parts VMI, motor coordination and visual perception. The VMI test consists of a sequence of geometric shapes that need to be copied on a record sheet with a pencil. The visual perceptual subtest presents with a similar sequence of geometric shapes, participants have to select identical shapes. There is a three-minute limit for each test item and a ceiling of three consecutive incorrect items. The motor coordination subtest is administered by drawing with a pencil on the record form and completing the geometric shape and staying within the boundaries. There is a five-minute limit to the test, all items are scored and there is no ceiling. The test is administered in 10 to 15 minutes, with approximately five minutes for each subsection. Raw scores can be converted to age specific norms, scaled scores and percentile ranks.

Overall, average reliability ICC scores were achieved, 0.92 for visual, 0.91 for motor and 0.89 for VMI subtests. Average test-retest coefficients of 0.87 for VMI, 0.84 for visual and 0.83 for motor were achieved over a 2-week period. High inter-scorer ICC reliability was achieved, 0.94 for VMI, 0.98 for Visual and 0.95 for motor (Beery, 1997).

5.5.3 Scholastic Assessment (Appendix O)

The researcher initially planned to use the Teachers Checklist (Richmond and Holland, 2010) to gain information on the functional outcomes of the study (Appendix L). The purpose was to evaluate whether the intervention that the participants received had an impact on their academic performance, linking the performance components with occupation. Upon consultation with supervisors, the researcher decided to use the one minute reading, addition and subtraction tests developed by the Human Sciences Research Council (1996). The scholastic assessment was the preferred choice due to the quantitative nature and information relating to literacy and numeracy that it provided. The test therefore provides objective facts regarding functional outcome. Bias was excluded by including this test in the data collection due to the standardisation of the test and the elimination of human opinion. The scholastic assessment was included to contribute to the fidelity and ascertain how skills gained through intervention can be applied to aspects of daily life (Bellg et al., 2004).

The one-minute scholastic assessment consists of reading, addition and subtraction tests. The Human Science Research Council (HSRC) of South Africa requested in 1996 that these tests be re-standardised, replacing outdated words and providing standardised written instructions. This is currently the latest version and there are no updates available. The reading test is administered by providing the participant with a reading plate and they are expected to read the list from left to right, with a one-minute time limit. The record form is identical to the reading plate and the administrator records and marks all the words read incorrectly. A raw score is determined according to amount of words read correctly and age norms are derived from that. The addition and subtraction test is administered by providing participants with pre-set addition and minus questions. Participants have one minute to do each test. The administrator then determines the raw score of all the questions answered correctly and derives age norms. The test manual stated that the test has been standardised and has good reliability and validity. The test is scored by marking all the correct responses and calculating a raw score by determining the total for each test. The raw scores are then converted to an age equivalent score by using the norm table in the test manual (Human Sciences Research Council, 1996). There are no statistics available or research specific to South Africa, which is a possible limitation to the study, however there are no other published tests available in the South African context to determine one-minute reading, addition and subtraction.

5.6 INTERVENTION

5.6.1 Routine Intervention Approach

In the research setting, visual perceptual deficits are traditionally treated in a reductionist nature. Learners are routinely assessed and visual perceptual deficits treated in the hierarchical order, as explained in Chapter 2. Visual perception is treated using various activities, such as 3D (constructional games), 2D (worksheets) or kinaesthetic activities. Various shapes, pictures, letters and numbers are used in the treatment of visual perceptual skills. Up to the date of this research, no multimedia or computer-based intervention was used for the remediation of visual perception skills. Learners also received visual perceptual worksheets to complete under the supervision of their parents as a home programme.

5.6.2. Computer-based Intervention Approach

Sony VAIO-W211AX/P laptops were used for this research project. These laptops are small and have a 10-inch screen; it has an Intel Atom processor, an HD 1366x768 pixel LCD display and 8 hour battery life. This laptop was an ideal tool for the computer-based intervention, due to size, mobility and battery life. Intervention was therefore not disrupted due to power interruptions. Intervention was conducted in a therapy office where the door could be closed to eliminate distractions.

During the computer-based intervention approach, participants were assessed as part of the baseline assessment. A problem list was established for each participant and provided to the research assistants as well as what aspects of the computer-based programme address the various aspects mentioned (Appendix Q). Visual perceptual constructs were not treated in a specific order in a reductionist nature and various aspects of the Dynamic Systems Theory Model of Visual Perception were incorporated into this therapy (Coté, 2015).

Aspects of attention were addressed by providing students with earphones that guided activities through auditory instructions. The earphones also blocked out background noise and aided concentration, which improved quality of task execution therefore incorporating aspects of language. The programme was available in both languages of teaching and learning, English and Afrikaans, so participants could engage in the language they were most familiar with at school. Auditory feedback was therefore also provided and the programme contained encouraging voice prompts. Knowledge and experience were incorporated by including the overarching theme of “sea world” that was within the participant’s frame of reference and to which they could relate.

In order to achieve meaningful participation, there must be a balance between required skills and challenge of the activity (Moneta and Csikszentmihalyi, 1996). Motivation was facilitated by having various levels indicated on the screen for each activity. Participants could therefore only progress to the next level once they had completed the required tasks for the current level. If a participant struggled with a certain activity, the programme provided more repetition on that specific aspect. The various levels provided learners with a sense of mastery and enhanced the motivation.

5.7 RESEARCH PROCEDURE

Once ethical clearance had been obtained from the Human Research Ethics Committee at the University of the Witwatersrand (M150615) (Appendix B) and permission had been provided by the Gauteng Education Department and the principal of the school (Appendix E and Appendix D), parents of learners selected to take part in the study were asked to give informed consent (Appendix C). Learners were asked for signed assent to take part in the study. Parents had to complete a demographic information sheet and a questionnaire that described their children’s electronic media habits. Parents of all participants were asked not to expose their children to any new electronic media for the duration of the study. Parents were also asked to send a medication list indicating all the medication their children were using, including prescribed medication, vitamins and homeopathic medicine.

5.7.1 Training of the research assistants

5.7.1.1 Recruitment

An invitation to be selected as a research assistant was extended to all occupational therapists within the research setting, and those interested were interviewed and selected on criteria of interest, competency with electronic media and motivation. The role of research assistant was to facilitate the computer-based intervention. Two research assistants who were working at the research setting were recruited to administer the computer-based intervention as part of the individualised intervention plan for each participant.

5.7.1.2 Training

Bellg et al. (2004) recommended that it was a requirement for intervention providers to be trained to ensure fidelity. The purpose of the computer-based intervention and its procedure were discussed at the training. The research assistants were given a handout with the computer-based intervention procedure, trained in the operation of the programme and instructed about their role in the intervention. They were also trained on the dynamic systems theory and the application to visual perception. Before qualifying as research assistants, each activity (Appendix Q) was demonstrated to the therapists and they were required to operate and participate in activities independently. Research assistants were instructed to upgrade or downgrade the activity should it be too easy or difficult for participants, and to teach participants how to log into and operate the *Sea World Adventures*™ programme independently. Research assistants were instructed to provide participants with personal positive labels that would predict behaviour ("You are a clever boy/girl and you are going to do very well today") at each session. At the beginning, end and throughout the computer-based intervention programme, positive feedback was requested. Duration of training was approximately 2 hours. The caseload was evenly distributed between the two research assistants. In order to eliminate bias, research assistants were requested to conduct the computer-based intervention on participants allocated to other therapists for routine intervention.

Research assistants were required to complete statistics of intervention to ensure that each participant received 20 computer-based intervention sessions. Together with the statistics, the research assistants were requested to provide comments on the participants' opinion of how they experienced each session as well make observations of their own about each session (Appendix P). The statistics allowed standardisation of the intervention and made the intervention easier to replicate therefore contributing to the delivery and receipt of the intervention (Bellg et al., 2004).

5.7.2 Data Collection

The study was a blinded study to reduce bias (Kielhofner, 2006). The researcher was blinded to the random allocation of participants to groups, which was completed by a research assistant who was another occupational therapist not involved in the treatment of the learners in this study. All the assessments were conducted by the researcher who assessed all the participants at baseline and then at the end of each intervention period using the TVPS-3 and Beery VMI and scholastic assessment. All assessments were conducted in a therapy room (that was familiar with participants) where the door could be closed to reduce distractions. Assessments were conducted in one sitting and order of application for all assessments was the same to ensure unity of results. The TVPS-3 was conducted first, followed by the Beery VMI and thereafter the scholastic assessment. The researcher determined the appropriate level of the computer-based intervention for each participant based on the results of these assessments.

The research assistants, who conducted the computer-based intervention, were aware of which group the participants were allocated to, but were blinded to the results of the visual perception assessments. They provided the computer-based programme for each participant based on the recommendations of the researcher within the school setting. All participants continued to receive weekly occupational therapy throughout the study duration from their treating occupational therapists.

The computer-based intervention was additional to the routine occupational therapy programme. Group 1 received the computer-based intervention as additional therapy programme twice week during the second school term for 10 weeks. In the 45-minute session available, 30 minutes were used for computer-based intervention (intervention A) and 15 minutes for routine therapy. During this period, Group 2 received traditional occupational therapy (intervention B) only (45 minutes). A "wash-out" period of 3 weeks followed when no treatment was provided to Groups 1 and 2 in the school holiday. During the third school term (10 weeks), intervention was crossed over and Group 2 then received intervention A and Group 1 received intervention B (Figure 5.1).

Participants were asked at the beginning of the session if they had been playing any new computer games at home. Research assistants were requested to make notes should that be the case, however no participants had done so. If any participants had played three or more new computer games during the study they would have been excluded during statistical analysis.

Results from the scholastic assessment and the assessments of visual perception (TVPS-3 and VMI) were entered into an Excel Worksheet to determine the progress in visual perception and academic performance.

5.7.3 Evaluation of the computer-based intervention

The research assistants who conducted the computer-based intervention were interviewed after completion of Intervention A and asked about any changes they noted in the participants' behaviour during the implementation of the computer-based visual perceptual programme. They were also asked to obtain information from the participants, parents and teachers about any behaviour changes during this period.

The researcher interviewed the research assistants at the end of the research process to collect feedback about the intervention. Information derived from the feedback interview included behaviour of participants, concentration of participants, usefulness and user-friendliness of the programme. They were also asked about any problems or benefits they observed during this period.

5.8 ETHICAL CONSIDERATIONS

Ethical clearance for this study was obtained (clearance number: M150615) from the Human Research Ethics Committee for at the University of the Witwatersrand (Appendix B). The principal of the school gave permission to conduct the research at the school (Appendix D) and the Gauteng Department of Education granted approval to conduct the study (Appendix E). Consent was obtained by handing out information letters to all parents of learners who met the inclusion criteria of the study (Appendix C); all the learners whose parents signed the informed consent were included in the study. Learners were also asked to give signed assent in terms of participating in the study. Two learners who did not give signed assent were excluded from the study.

Names of participants and personal data were stored in a separate secret location by the researcher. Confidentiality was ensured by assigning a code to each participant and identifying records were kept separate and in a secure location by the researcher. Parents and children were informed they had the right to withdraw at any time during the study without consequence. Feedback was given to research assistants and parents upon request. Participants continued with their routine therapy programme and were not disadvantaged in any way when not involved in the computer-based intervention.

5.9 DATA ANALYSIS

A statistician was consulted to assist with statistical analysis and hypothesis testing. The data were entered into a Microsoft Excel file and analysed with the guidance of a statistician. Statistica v 13.2 was used to analyse data. Descriptive statistics were used to represent the demographic data as well as the test results and evaluations of the treatment sessions for both groups.

Due to the small sample size in each group, the data were not normally distributed and therefore non-parametric statistics were used. The percentile scores for the Beery VMI assessment and the TVPS-3 were summarised using median scores with lower and upper quartiles reported.

The Wilcoxon Matched Pairs Test was used to determine results within the groups and the hypothesis testing (Kielhofner, 2006). This was to test for significant difference changes in the visual perception and functional academic tasks of the participants ($p \leq 0.05$) and replaced the paired t-test method. The Mann Whitney U test was used to determine the medians between group results; the medians were then compared to determine p-value and z scores (Kielhofner, 2006). The Mann Whitney U test was selected because to the two groups taken from the different samples. This test is used to determine significant differences between two groups.

5.9 RESULTS

5.9.1 Demographic data of participants

Fifty learners participated in the study. Group 1 and 2 had the same sample size of 25 participants each. Gender distribution of the sample was 68% boys and 32% girls. Age ranges of participants were between 7 years 0 months and 9 years 11 months, with almost equal numbers of participants in Grade1, Grade 2 and Grade 3. The language of teaching and learning was English and Afrikaans and participants came from a variety of population groups (Table 5.2).

Table 5.2: Demographic data of the study sample (n=50)

Sex:	**n(%)**	**Medication:**	**n(%)**
Boys	34 (68%)	**Concerta 18mg**	7 (14%)
Girls	16 (32%)	**Concerta 36mg**	6 (12%)
Language of instruction		**Concerta 54mg**	4(8%)
Afrikaans:	33 (66%)	**No Medication**	6 (12%)
English:	17 (44%)	**Risperdal 2mg**	1 (2%)
Grade:		**Ritalin 10mg**	6 (12%)
1	16 (32%)	**Ritalin 20mg SR**	2 (4%)
2	16 (32%)	**Ritalin 20mg LA**	5 (10%)
3	18 (36%)	**Ritalin 30mg LA**	2 (10%)
Population Group		**Ritalin 5mg**	3 (6%)
White:	42 (84%)	**Strattera 10mg**	1 (2%)
African:	5 (10%)	**Strattera 18mg**	1 (2%)
Indian:	1 (2%)	**Strattera 25mg**	6 (12%)
Coloured:	2 (4%)		

While 12 (6%) of participants did not take medication, the other research participants used a variety of medication prescribed for ADHD, including Concerta (36mg and 54mg), (Risperdal (2mg), Ritalin SR (10mg and 20mg), Ritalin LA (20mg and 30mg), Ritalin (5mg) as well as Strattera (10mg, 18mg and 25mg) (Table 5.2).

5.9.2 Results of parental questionnaire on the multimedia behaviour of participants

Parents were requested to complete a questionnaire containing information regarding the multimedia use of their children prior to the study. Parents reported that 98% of participants watch television on a daily basis and the amount of screen time varied from day to day depending on their routine. Some parents indicated they restrict screen time and use it as a reward as part of a behaviour modification programme. The average amount of screen time was between 5 minutes and 2 hours, and the duration of usage was mostly daily; participants engaged in electronic media more than twice a day.

Most of the participants were familiar with various types of multimedia devices (Table 5.3) and gender differences had an impact on the type of games in which participants engaged. Boys enjoy strategy, fighting and racing games, while girls prefer games of a creative nature, such as fashion design, beauty makeovers, dress up or puzzles. The age of participants determined the difficulty level of the game. A few parents (12%) stated their children were playing educational games that included spelling and maths exercises.

Table 5.3 Device and software use for participants reported by parents (n=50)

Electronic devices used	**n (%)**
Laptops	7 (14%)
Desktop Computers	2 (4%)
Tablet	18 (36%)
Smartphones	36 (72%)
Handheld devices – PsP, Gameboy	3 (6%)
Software used	
Skype	3 (6%)
Games with motion sensors-Wii, Xbox, Kintetic,	9 (18%)
Games -PlayStation, Xbox, Sega	5 (10%)

Electronic media was also used for communication purposes by 42% of participants. Parents reported that participants utilise smartphones for text or voice messages, and 6% of participants used Skype on a weekly basis to communicate with relatives who lived far away.

5.9.3 Results of Visual Perceptual and Scholastic Assessments

This section will report on the results and changes that took place within each group, A and B respectively. The Beery assessment (VMI, Visual Perception), TVPS-3 (overall, basic processes, sequencing and complex processes) and scholastic (reading, addition and subtraction) results will be reported on.

5.9.3.1 Within group results

Beery Developmental Test of Visual Motor Integration

Group 1

The baseline standard scores on the Beery VMI on Assessment 1 Group 1 were 87 and 86 for VMI and motor coordination respectively; these scores fall just above the -1SD z score, indicating dysfunction on the Beery VMI test. The score for visual perception at 77 was equivalent to a -1.5 z score indicating dysfunction in this component on the Beery VMI test. This group achieved a highly significant improvement (p=0.001) in the VMI, visual perceptual and motor coordination standard scores in Intervention A where they received computer-based visual perception and routine intervention. The participants achieved median standard scores of 94. 96 and 92 for the VMI, visual perceptual and motor coordination tests respectively. The greatest improvement was 19 points in the standard score, a score equivalent to a z score of -0.30. The scores indicated that the group no longer fell in the dysfunctional range in any section of the Beery VMI test (Table 5.6).

In Assessment 3, a statistically significant improvement was maintained in Intervention B where they received routine intervention for VMI (p=0.003) and visual perception (p=0.001). The standard score for visual perception indicated an average z score of 0.05, indicating average ability in this aspect of the Beery VMI test. These results indicate possible carry over effect from Intervention A into the period of Intervention B with improvement in cognitive abilities and learning in VMI. Improvement in motor coordination did occur during Intervention B period but this was not statistically significant (Table 5.4).

Table 5.4: Beery Developmental Test of Visual Motor Integration - Group 1

	Assessment 1 Baseline assessment	Assessment 2 Intervention A			Assessment 3 Intervention B		
Group 1							
	Median (Lower and Upper Quartile)	Median (Lower and Upper Quartile)	Change	p value	Median (Lower and Upper Quartile)	Change	p value
		Routine and computer-based			Routine		
Visual Motor Integration	87 (79-93)	94 (90-97)	7	0.001**	96 (93-101)	2	0.003**
Visual perception	77 (74-84)	96 (93-101)	19	0.001**	101 (98-106)	5	0.001**
Motor Co-ordination	86 (81-90)	92 (89-95)	6	0.001**	93 (90-97)	1	0.079

Significance p=0.05*
Significance p= 0.01**

Group 2

The baseline standard scores on the Beery VMI for Assessment 1 Group 2 were at and below 85 for VMI, visual perception and motor coordination respectively. These scores fall below the -1SD z score indicating dysfunction on the Beery VMI test. Upon completion of Intervention B, or routine intervention, the scores for VMI and motor coordination for this group moved to above 85 or -1 z score on the Beery VMI test, while the standard score for visual perception remained at .81 indicating dysfunction. The improvement was not statistically significant.

In Assessment 3, a statistically significant improvement was maintained in Intervention B where they received routine intervention for VMI (p=0.003) and visual perception. (p=0.001). The standard score for visual perception indicated an average z score of 0.05, indicating average ability in this aspect of the Beery VMI test. These results indicate possible carry over effect from Intervention A into the period of Intervention B with improvement in cognitive abilities and learning in VMI.

Improvement in motor coordination did occur during Intervention B period but this was not statistically significant (Table 5.5).

Table 5.5: Beery Developmental Test of Visual Motor Integration - Group 2

	Assessment 1 Baseline assessment	Assessment 2 Intervention A			Assessment 3 Intervention B		
Group 2							
	Median (Lower and Upper Quartile)	Median (Lower and Upper Quartile)	Change	p value	Median (Lower and Upper Quartile)	Change	p value
		Routine			Routine and computer-based		
Visual Motor Integration	84 (77-84)	87 (84-91)	3	0.917	96 (82-88)	9	0.001**
Visual perception	81 (76-88)	81 (80-88)	0	0.116	101 (96-106)	20	0,001**
Motor Co-ordination	85 (81-90)	89 (85-93)	4	0.732	95 (91-98)	6	0.001**

Significance p=0.05*
Significance p= 0.01**

These results indicate the benefit participants received from intervention in terms of visual perception in particular, which improved by at least 1SD in both groups after they completed the computer-based visual perception and routine intervention when compared to improvement gained during routine intervention only.

Test of Visual Perceptual Skills – 3rd Edition

Group 1

On the baseline assessment, the standard scores for Group 1 for the overall TVPS - 2 assessment as well as the basic processes, sequencing and complex processes ranged from 76 to 80. These fell into a range that indicated dysfunction for visual perception at -1.60 and -1.35 z scores. Group 1 attained highly significant results after Intervention A when they received computer-based and routine intervention. The standard scores for the four sections of the TVPS-3 ranged from 99 to 103 in Assessment 2, which placed the participants' skills at -0.05 to 0,2 z scores indicating they no longer fell into a dysfunctional range for visual perception.

In Assessment 3, a statistically significant improvement was maintained in Intervention B only for the overall test median standard score, which reached 100. None of the other median standard scores improved for the basic processes, sequencing or complex processes scores, which improved during the period of Intervention B when the participants received routine therapy only (Table 5.6).

Table 5.6: Test of Visual Perceptual Skills – 3rd Edition for Group 1

	Assessment 1 Baseline assessment	Assessment 2 Intervention A			Assessment 3 Intervention B		
Group 1							
	Median (Lower and Upper Quartile)	Median (Lower and Upper Quartile)	Change	p value	Median (Lower and Upper Quartile)	Change	p value
		Routine and computer-based			Routine		
TVPS-3 Overall	78 (76-80)	99 (93-101)	21	0.001**	100 (97-103)	1	0.047*
TVPS-3 Basic Processes	76 (74-84)	99 (94-103)	23	0.001**	99 (95-103)	0	0.531
TVPS-3 sequencing	80 (75-85)	100 (95-100)	20	0,001**	100 (96-101)	0	0.468
TVPS-3 complex processes	80 (75-83)	103 (95-105)	23	0,001**	103 (98-108)	0	0.153

Significance p=0.05*
Significance p= 0.01**

Group 2

On the baseline assessment, the standard scores for Group 2 for the overall TVPS -2 assessment as well as the basic processes, sequencing and complex processes ranged from 77 to 80. These fell into a range that indicated dysfunction for visual perception at -1.55 and -1.35 z scores. Although there was a significant improvement for three of the four sections of the TVPS-3 after intervention, none of the standard scores reached 85 as the change in scores was small and the participants remained at a level below -1 z scores, indicating dysfunction in visual perceptual skills.

The median standard scores for sequencing did not change during the period of Intervention B when the participants received routine therapy only (Table 5.7).

Table 5.7: Test of Visual Perceptual Skills – 3rd Edition for Group 2

	Assessment 1 Baseline assessment	Assessment 2 Intervention A			Assessment 3 Intervention B		
Group 2							
	Median (Lower and Upper Quartile)	Median (Lower and Upper Quartile)	Change	p value	Median (Lower and Upper Quartile)	Change	p value
		Routine			Routine and computer-based		
TVPS-3 Overall	79 (76-83)	83 (80-86)	4	0.002**	102 (99-104)	19	0.001**
TVPS-3 Basic Processes	77 (76-83)	81 (79-85)	4	0.002**	101 (98-104)	20	0.001**
TVPS-3 sequencing	80 (70-85)	80 (80-85)	0	0.067	100 (95-105)	20	0.001**
TVPS-3 complex processes	80 (75-85)	85 (83-88)	5	0.001**	105(100-110)	20	0.001**

Significance p=0.05*
Significance p= 0.01**

In Assessment 3, a highly statistically significant difference was attained for Group 2 after Intervention A when they received computer-based and routine intervention. The change of scores between 19 and 20 points meant the standard scores for the four sections of the TVPS-3 ranged from 100 to 105 at Assessment 2, which placed the participants' skills at 0 to 0,35 z scores indicating they no longer fell into a dysfunctional range for visual perception.

Greater changes in the standard scores with the participants' visual perceptual skills were found for Intervention A, indicating the computer-based visual perceptual programme and routine intervention was more beneficial to the participants in both groups than Intervention B or routine intervention alone.

Scholastic Assessment

Group 1

For reading Group 1 improved significantly (p=0.001) in assessment 2 with a median value of 91 months (7 years 6 months) to a median value of 103 months (8 years 6 months) after Intervention A, the computer-based visual perceptual and routine intervention (Table 5.8).

Table 5.8: Scholastic assessment for Group 1

	Assessment 1 Baseline assessment	**Assessment 2 Intervention A**			**Assessment 3 Intervention B**		
Group 1							
	Median (Lower and Upper Quartile)	**Median (Lower and Upper Quartile)**	**Change**	**p value**	**Median (Lower and Upper Quartile)**	**Change**	**p value**
		Routine and computer-based			**Routine**		
Reading	91 (80-99)	103 (89-106)	12	0.001**	105 (93-110)	3	0.001**
Addition	96 (85-99)	104 (96-110)	8	0.001**	108 (98-112)	4	0.002**
Subtraction	98 (86-100)	102 (98-109)	4	0,001**	100 (96-101)	-2	0.007**

Significance p=0.05*
Significance p= 0.01**

After routine intervention, only in Intervention B at Assessment 3 did they improve significantly (p=0.001), again to a median value of 105 months (8 years 7 months), indicating further positive change.

Although change after both interventions was significant, greater change after Intervention A, suggests that the computer-based visual perceptual intervention and routine intervention may have had more effect on reading achievement than routine intervention only.

Although the change for addition and subtraction was highly significant from the 96 and 98 months (8 years, 0 months and 8 years and 2 months) to a median value of

104 and 102 months (8 years 7 months and 8 years 5 months) after Intervention A, the change was not as great as that for reading.

Scores of participants did increase significantly at Assessment 3 after Intervention B for addition but decreased significantly for subtraction. These small changes could be related to the routine intervention and usual classwork they received during the two intervention periods, although the greater change in scores may indicate that they did benefit from improvements in visual perception when doing arithmetic.

Group 2

For reading, Group 2 improved significantly (p=0.001) in Assessment 2 from a median value of 91 months (7 years 6 months) to the median value of 96 (8 years) after routine intervention (Table 5.9).

Table 5.9: Scholastic Assessment for Group 2

	Assessment 1-Baseline assessment	Assessment 2 Intervention A			Assessment 3 Intervention B		
Group 2							
	Median (Lower and Upper Quartile)	Median (Lower and Upper Quartile)	Change	p value	Median (Lower and Upper Quartile)	Change	p value
		Routine			Routine and computer-based		
Reading	91 (85-98)	96 (86-100)	5	0.001**	103 (96-110)	7	0.001**
Addition	91 (89-99)	99 (93-103)	8	0.001**	104 (99-112)	5	0.001**
Subtraction	93 (88-98)	98 (93-102)	5	0,001**	105 (102-109)	7	0.001**

Significance p=0.05*
Significance p= 0.01**

In Assessment 3, after the computer-based visual perceptual intervention, they improved significantly (p=0.001) again to a median value of 103 (8 years 5 months), indicating further positive change. Although change after both interventions was significant, greater change after Intervention A was obtained when participants received computer-based visual perceptual intervention and routine intervention. Results do not indicate clearly if the computer-based visual perceptual intervention and routine intervention may have had more effect on reading achievement than routine intervention only.

The change for addition and subtraction was highly significant from the 91 months (7 years 6 months) and 93 months (7 years and 8 months) to a median value of 99 and 98 months (8 years 3 months and 8 years 2 months) after Intervention B. These small changes could be related to the routine intervention and usual classwork they received during the intervention period. The participants' scores also increased significantly at Assessment 3 after Intervention A for addition and subtraction. The increase was slightly greater for subtraction but less than that for addition after Intervention B. These small changes could be related to the routine intervention and usual classwork, and do not indicate if the participants benefitted from improvements in visual perception when doing arithmetic.

5.9.3.2 Between group results

Between groups results examines the difference in scores between Group 1 and Group 2 at different intervention periods (Intervention A and Intervention B). Significance differences between the groups were determined using the non-parametric Mann Whitney U test. Table 4.10 illustrates the baseline scores (z-scores) of the Beery VMI, TVPS-3 and Scholastic test for Group 1 and 2. According to Table 4.10 both groups had equivalent baseline scores.

Table 5.10 Baseline scores (z-score) for Group 1 and 2

	Group 1	Group 2
Beery VMI		
VMI	-1.105	-1.108
VP	1.367	1.369
MC	0.009	0.009
TVPS-3		
Overall	0.349	0.351
Basic Processes	0.164	0.165
Complex Processes	0.74	0.75
SCHOLASTIC ASSESSMENT		
Reading	0.058	0.058
Addition	-0.310	-0.311
Subtraction	-0.291	-0.292

Beery Developmental Test of Visual Motor Integration

The results for the Beery VMI test were analysed according to three sections, VMI and the supplemental tests for visual perception and motor coordination. There was no significant difference for VMI, visual perception or motor coordination standard scores at the baseline Assessment 1 between the two groups, indicating they were comparable at this stage.

Once Group 1 had completed Intervention A, during which they received the computer-based intervention and routine intervention, it was found their standard scores for two sections of the Beery VMI test (VMI and visual perception) were significantly higher than those of Group 2 who received routine intervention only (Table 5.3). Although the motor coordination standard scores for Group 1 did improve during this intervention period, the improvement was smaller than for the other two sections of the Beery VMI test and the difference between the groups at Assessment 2 was not significant, as both groups improved.

In Assessment 3, there was no significant difference between the two groups once Group 2 had completed Intervention A and received the computer-based intervention and routine intervention, while Group 1 received routine therapy only. The standard scores for the groups at this assessment were similar, indicating that all participants had benefitted from the interventions received although the results at Assessments 2 and 3 indicate greater improvement when the participants received Intervention A, which included computer-based intervention (Table 5.11).

Table 5.11: Comparison of the scores at assessment 1, 2 and 3 for Group 1 and 2 on the Beery Developmental Test of Visual Motor Integration

	Assessment 1 Baseline assessment			**Assessment 2 Intervention A**			**Assessment 3 Intervention B**		
	Median (Lower and Upper Quartile)		**p value**	**Median (Lower and Upper Quartile)**		**p value**	**Median (Lower and Upper Quartile)**		**p value**
	Group 1	**Group 2**		**Group 1** Routine and computer-based	**Group 2** Routine		**Group 1** Routine	**Group 2** Routine and computer-based	
Visual Motor Integration	87 (79-93)	84 (77-84)	0.271	94 (90-97)	87 (84-91)	0.002**	96 (93-101)	96 (82-88)	0.630
Visual perception	77 (74-84)	81 (76-88)	1.697	96 (93-101)	81 (80-88)	0.001**	101 (98-106)	101 (96-106)	1.000
Motor Co-ordination	86 (81-90)	85 (81-90)	0.984	92 (89-95)	89 (85-93)	0.175	93 (90-97)	95 (91-98)	0.279

Significance p=0.05*
Significance p= 0.01**

Test of Visual Perceptual Skills – 3rd Edition

The overall index score includes the sum of scaled scores of all the subtests (Martin 2006). Subtests were clustered together due to the interrelatedness of visual perceptual skills and classified as index scores. There are four categories of index scores: overall, basic process, sequencing and complex processes (Martin 2006)(Table 5.12).

Table 5.12: Comparison of the scores at assessment 1, 2 and 3 for Group 1 and 2 on the Test of Visual Perceptual Skills -3

	Assessment 1- Baseline assessment			Assessment 2 Intervention A			Assessment 3 Intervention B		
	Median (Lower and Upper Quartile)		p value	Median (Lower and Upper Quartile)		p value	Median (Lower and Upper Quartile)		p value
	Group 1	Group 2		Group 1 Routine and computer -based	Group 2 Routine		Group 1 Routine	Group 2 Routine and computer -based	
TVPS-3 Overall	78 (76-80)	79 (76-83)	0.729	99 (93-101)	83 (80-86)	0.001**	100 (97-103)	102 (99-104)	0.163
TVPS-3 Basic Processes	76 (74-84)	77 (76-83)	0.862	99 (94-103)	81 (79-85)	0.001**	99 (95-103)	101 (98-104)	0.074
TVPS-3 Sequencing	80 (75-85)	80 (70-85)	0.603	100 (95-100)	80 (80-85)	0.001**	100 (96-101)	100 (95-105)	0.325
TVPS-3 Complex processes	80 (75-83)	80 (75-85)	0.452	103 (95-105)	85 (83-88)	0.001**	103 (98-108)	105 (100-110)	0.271

Significance p=0.05*
Significance p= 0.01**

Basic process index score is the sum of scaled scores from the visual discrimination, visual memory, spatial relations and form constancy subtests. Sequencing index score includes only the sequential memory subtest, and the complex processes index scores include the sum of scaled scores from the figure ground and visual closure subtests (Martin 2006).

There was no significant difference for TVPS-3 in the overall, basic processes, sequencing and complex processes standard scores at the baseline Assessment 1 between the two groups indicating they were comparable at this stage.

Highly significant differences (p=0.001) were obtained between Group 1 and Group 2 in Assessment 2 after Group 1 received computer-based visual perceptual intervention and routine intervention during period 1 and Group 2 only received routine intervention. This indicates that participants in Group 1 had benefitted from Intervention A at Assessment 2 with greater improvements in visual perception than Group 2.

In Assessment 3, there was no significant difference between Group 1 and Group 2 once Group 2 had completed Intervention A and received the computer-based intervention and routine intervention, while Group 1 received routine therapy only. The standard scores for the groups at this assessment were similar indicating that all participants had benefitted from the interventions (Table 5.12).

Scholastic Assessment

The scholastic assessment consisted of a one-minute reading accuracy, one-minute addition and one-minute subtraction test.

There was no significant difference for scholastic achievement in the reading, addition and subtraction standard scores at the baseline of Assessment 1 between the two groups, indicating they were comparable at this stage. This assessment does not provide standard scores only age norms in months.

Between groups results for the scholastic assessment yielded significant results in Assessment 2 after Group 1 received the computer-based visual perceptual intervention combined with routine intervention and Group 2 received routine intervention for reading only. Both groups also had improvement in addition and subtraction and although the standard scores were higher for Group 1, the difference between the two groups was not significant (Table 5.13). While Intervention A may have had an impact on reading due to the significant improvement found on the visual perceptual assessments, other variables such as routine therapy and classroom achievements may have affected these results.

Table 5.13: Comparison of the scores at assessment 1, 2 and 3 for Group 1 and 2 for Scholastic Achievement

	Assessment 1- Baseline assessment			Assessment 2 Intervention A			Assessment 3 Intervention B		
	Median (Lower and Upper Quartile)		p value	Median (Lower and Upper Quartile)		p value	Median (Lower and Upper Quartile)		p value
	Group 1	Group 2		Group 1 Routine and computer-based	Group 2 Routine		Group 1 Routine	Group 2 Routine and computer-based	
Reading	91 (80-99)	91 (85-98)	0.954	103 (89-106)	96 (86-100)	0.047*	105 (93-110)	103 (96-110)	0.969
Addition	96 (85-99)	91 (89-99)	0.758	104 (96-110)	99 (93-103)	0.062	108 (98-112)	104 (99-112)	0.743
Subtraction	98 (86-100)	93 (88-98)	0.772	102 (98-109)	98 (93-102)	0.175	100 (96-101)	105 (102-109)	0.772

Significance p=0.05*
Significance p= 0.01**

In Assessment 3 there was no significant difference between the two groups once Group 2 had completed Intervention A and received the computer-based intervention and routine intervention while Group 1 received routine therapy only. The standard scores for the groups at this assessment illustrated a greater increase in scores for Group 2, indicating that computer-based intervention and routine intervention may have had an impact on the scholastic achievement during this period (Table 5.13).

5.9.4 Evaluation of the computer-based intervention

Research assistants observed that some of the participants had never worked with a laptop or a touch pad before and this required them to practice before being comfortable with using the computers.

The programme used was suitable for the abilities of the participants, and they were motivated to complete the computer-based intervention, which was confirmed by teachers and parents' feedback.

The switch between different activities was time consuming and the introduction at the beginning of the programme took too long. The research assistants reported that not all the content of the visual perceptual computer programme was relevant to the participants in the study.

One advantage of using a laptop computer was the portability of the device meaning the intervention could continue if a venue change was required due to noise levels or other reasons. Future intervention can also occur within the classroom setting and will be beneficial in providing access to additional interventions as part of the individualised support plan. The long battery life (approximately nine hours) ensures that intervention can continue even if there is a power failure.

5.9.5 Summary of Results

5.9.5.1 Within group results

Group 1

Highly significant scores were obtained after Intervention A (additional computer-based intervention) for Beery VMI, motor coordination, the visual perception, all TVPS-3 index scores (overall, basic processes, sequencing and complex processes) and scholastic assessment (reading, addition and subtraction). The group improved so that all scores fell into the normal range above -1 SD after Intervention A for VMI, motor coordination, Visual perception, all TVPS-3 index scores (overall, basic processes, sequencing and complex processes and scholastic assessment (reading, addition and subtraction). Improvement was maintained after Intervention B (routine intervention) during Assessment 3.

Group 2

Beery VMI, motor coordination and visual perception, all TVPS-3 index scores (overall, basic processes, sequencing and complex processes), and scholastic assessment (reading, addition and subtraction).

Group 2 improved in Assessment 2 but remained within the dysfunction range at less than -1SD after intervention B (routine intervention). Significant results were obtained for Group 2 after Intervention A (additional computer-based intervention) during Assessment 3 for. Beery VMI, motor coordination, visual perception, all TVPS-3 index scores (overall, basic processes, sequencing and complex processes), and scholastic assessment (reading, addition and subtraction).

5.9.5.2 Between group results

Results for Groups A and B were non-significant during Assessment 1 (for all assessments), indicating the two groups were comparable prior to the intervention phase. Z scores for Group 1 and 2 were within the dysfunction range in Assessment 1 at below -1 SD for Beery VMI, Motor Coordination, Visual Perception and TVPS-3.

Significant differences were obtained between Groups 1 and 2 for the scores on the Beery VMI test for VMI and the visual perception during Assessment 2, indicating the effectiveness of intervention A (additional computer-based intervention) for Group 1. Groups 1 and 2 scores improved for the motor coordination sentimental test, however, the results were not significant. Highly significant differences were recorded between Groups A and B after Assessment 2 for the scores on the overall, basic processes, sequencing and complex processes of the TVPS-3. Results indicated that after Intervention A (additional computer-based intervention), Group 1 achieved significantly higher scores and that the median score now fell into a range indicating normal function above -1 SD on the test for this group.

Reading was the only scholastic assessment that yielded significant results in Assessment 2 for Group 1 compared to Group 2 after the additional computer-based intervention. The scores for all aspects of scholastic achievement improved more during Intervention A (additional computer-based intervention) for Group 1, but not for Group 2.

Results of between group effects of Assessment 3 were non-significant across all groups due to improvement of Group 2 after they had completed Intervention A (additional computer-based intervention). All the scores for Group 2 were similar to Group 1 at this stage. All standard scores improved for both groups to from scores indicating dysfunction at below -1SD to scores that fell close to the mean standard score of 100 indicating normal performance.

CHAPTER 6:
DISCUSSION - PHASE 1-3

"If we teach today, as we taught yesterday we rob our children from tomorrow."

-John Dewey

6.1 INTRODUCTION- PHASE 1

The purpose of Phase 1 was to determine if learners diagnosed with ADHD at the research setting experienced difficulties with visual perception, particularly to identify the most prevalent visual perceptual constructs that was at risk. Learners diagnosed with ADHD often present with scholastic challenges due to distractibility, inattention and poor concentration. Therefore, utilising a bottom up approach and investigating the possibility of visual perceptual dysfunction might assist in intervention planning for these learners. A record review was employed in this section and findings were discussed considering relevant literature.

6.1.1 Demographics

Upon examining literature, it confirmed that optimal visual perceptual development takes place between 8 and 10 years of age, and this is an important developmental period for visual perceptual development in learners for the acquisition of academic skills (Schneck, 2010b; Vlok et al., 2011a). Thus, including learners from the foundation phase in Grades 1, 2 and 3 for the study was appropriate when considering the assessment for visual perceptual deficits.

Eighty percent of the learners diagnosed with ADHD in the current study took medication, which is higher than that reported in America in 2016 (Danielson et al., 2018). The use or non-use of medication by learners is usually due to parents not giving consent, lack of parental funding or resources, as the medication is expensive (Forness and Kavale, 2001). Non-use of medication for concentration may affect the learners' ability to concentrate and thus their performance on the TVPS-3, as was shown by Papavasiliou et al. (2007) in their study. Although this may have been an interfering variable, it was not found to be an issue in the current study and it was accepted that when analysing the results all learners profiles could be included. The purpose of this study was to describe the visual perceptual deficits in learners with ADHD as recorded at the school so that appropriate intervention could be planned.

6.1.2 Visual Perceptual Deficits

Visual discrimination, visual closure, visual spatial relations visual memory and visual sequential memory deficits occurred most frequently, with approximately 73 to 61% of the learners having deficits in these client factors on the motor free TVPS-R. These scores agreed with the findings of Papavasiliou et al. (2007), who established that learners aged 7 to 11 years old diagnosed with ADHD had deficits in all the subtests on the TVPS-R, with the exception of figure ground perception. Their study differed in that form constancy presented as a greater deficit than in the current study (Papavasiliou et al., 2007). This was also true in a study by Germano et al. (2013) on visual perceptual dysfunction in boys with ADHD in Grades 2 to 5. These differences may be accounted for by the occupational therapy intervention that some learners in the current study had received in Grades 1, 2 and 3. Miranda et al (2002) found that this one aspect of visual perception improved significantly in learners with ADHD after school-based multicomponent intervention at school other than a significant difference in form constancy. Germano et al. (2013) also found learners with ADHD differed significantly from the typical population for scores of spatial position when tested on the DVPT-2, which is not a motor free test. In the current study, 70% of learners had difficulty with visual spatial relations and it was the second most prevalent visual perceptual construct. This confirms that visual spatial relations should be included in the invention programme because it appears that learners may have difficulties with spatial relationships in later grades. This was also concurrent with the findings of Kurtz (2006), that when spatial relations are deficient in learners diagnosed with ADHD they often reverse letters when reading or writing, have difficulty learning left and right, and poor spatial organisation affecting their academic performance.

Mirzakhany et al. (2016) found lower mean scores for visual closure in learners aged 7 to 12 years with ADHD and dyslexia. Higher scores were obtained for learners with ADHD alone, but when combined, the scaled scores were equivalent to those in the current study. In the current study, 69% of learners had difficulty with visual closure, which was the third most prevalent visual perceptual challenge. This confirms that visual closure requires intervention in a high percentage of learners with ADHD.

Although research by Richmond and Holland (2010) in South Africa recommended that visual memory and visual sequential memory should be treated together because the subtests appear to be similarly precise in determining challenges in short term memory, this was not found to be true in the current study. Their study was however not specific to learners with ADHD (Richmond and Holland, 2011). Crawford and Dewey (2008) and Mirzakhany et al. (2016) found that learners diagnosed with ADHD had a lower mean score on visual sequential memory than visual memory on the TVPS-R (Crawford and Dewey, 2008; Mirzakhany et al., 2016). In the current study, visual memory was the most prevalent visual perceptual challenge and 73% of leaners performed below average, but only 61% of participants performed below average in visual sequential memory. A higher percentage of learners had scaled scores below 8 in the current study, which supports the results of Kibby et al. (2015) that only learners with reading deficits and ADHD demonstrate visual sequential memory deficits when compared to typical peers (Kibby et al., 2015). Since not all learners with ADHD have reading deficits, it was expected that a smaller percentage of learners presented with visual sequential memory deficits in the current study. The deficits they did present with were more pronounced, indicating that both memory and sequential memory were amongst the common problems observed in children with ADHD.

The findings of the current study are concurrent with theorists who agreed that cognitive processing skills of visual attention, visual memory and visual discrimination depend on each other to function optimally (Todd, 1993). Visual discrimination is a foundation of visual perceptual skills and is inter-correlated with visual memory, form constancy and spatial perception (Martin, 2006; Schneck, 2010a). Although discrimination may also affect visual closure and figure ground perception this was not found to be true in the current study, with fewer learners with ADHD having deficits in these two areas measured on the TVPS-R.

6.1.3 Conclusion

The most commonly occurring visual perceptual deficits in the sample of learners at the school included visual discrimination, visual closure, visual spatial relations, visual memory and visual sequential memory. These results are, with the exception of that for visual closure, supported by other studies on visual perceptual deficits for children with ADHD. Visual closure is regarded as one of the most complex and higher level visual perceptual processing skills (Martin 2006). Therefore it is important to include in an intervention plan because it plays a major role in reading and other functional activities (Martin 2006; Schneck, 2010b). The outcome of Phase 1 also confirms that learners diagnosed with ADHD experience a definite challenge with visual perceptual skills as confirmed in literature. It would therefore be meaningful to consider the effectiveness of a visual perceptual intervention programme for learners diagnosed with ADHD.

These results were considered to guide the development of invention criteria from which a motor free computer-based intervention programme should be selected to improve visual perception of participants.

6.2 DISCUSSION - PHASE 2

6.2.1 Introduction

The development of an intervention criteria checklist for the treatment of visual perceptual deficits in learners with ADHD will be discussed as well as the selection an appropriate computer programme for the remediation of visual perceptual skills for learners diagnosed with ADHD.

6.2.2 Development of intervention criteria

Phase 2 of the study used a literature review and a nominal group to establish fidelity for the intervention criteria for the treatment of visual perceptual deficits in learners with ADHD. These criteria provided a fidelity tool to assist with the selection of an appropriate computer programme to use for the intervention. According to Murphy and Gutman (2012) the fidelity tool or intervention checklist is essential in ensuring that all the influencing factors for the intervention are taken into account (Murphy and Gutman, 2012). As suggested by Borelli et al. (2005) fidelity for the intervention of visual perceptual deficits was based on the design of a checklist comprised of criteria essential to evaluate or replicate the intervention.

Bellg et al. (2004) and Borelli et al. (2005) differentiated intervention fidelity into five basic components with the first component of identifying intervention criteria being completed in this phase of the study. This included the criteria or elements of intervention such as treatment principles and grading as Teague et al. (1998) and Borelli et al. (2005) confirmed that therapeutic principles are the foundation of intervention fidelity and contribute to evidence-based practice. The other components of fidelity such as training those implementing the intervention, setting the dose of intervention, intervention delivery and evaluation of the receipt of intervention were considered in Phase 3 of the study. As suggested by Bellg et al. (2004) the content of intervention was considered in Phase 2 of the study but the dose of intervention which should also be included in an intervention fidelity tool could only be assessed from the pre-nominal group questionnaire. Only three participants indicated that they had used electronic media as a therapeutic tool and indicated that they used the electronic media for 15-40 minutes per session. Previous research using electronic media for treating visual perceptual skills agreed with the duration of use (Wuanga et al., 2018; Chen et al., 2013; Lee et al., 2013) with Poon et al. (2010) using a 45 min intervention period in their study. Therefore, it was decided that additional computer-based intervention would be presented for 30 minutes during Phase 3 of the study.

The nominal group was used to determine the intervention criteria and fidelity of the intervention. Participants were selected based on inclusion criteria that were determined on their expertise in the field. According to Parham et al. (2011) the level of professional experience and training of participants contributes to the validity and reliability of the fidelity measure (Parham et al., 2011). Although McMillan et al. (2016) suggested that two to fourteen participants can be included in a nominal group the inclusion of eight participants in the nominal group was in line with their ideal number of seven participants (McMillan et al., 2016). Intervention criteria based on theoretical frameworks were presented to the participants in the nominal group for review. Participants also had the opportunity to generate their own ideas. The top rated weighting of the criteria will be discussed as well as any additions or changes recommended by the participants in the nominal group.

6.2.3 Visual Memory

When considering treatment and grading principles visual memory received the highest rating (19,38%) of the total intervention. This can be attributed to the visual memory being essential to all other visual cognitive components in the Framework of Hierarchical Development of Visual-Perception. Therefore, resulted in a large amount of research and literature pertaining to treatment and grading principles of visual memory as described in Table 4.1. Experts that participated in the NGT agreed and reported that although visual memory is a complex skill, they have observed great progress in other areas of visual perception once visual memory has been remediated. Schneck (2010a) also confirmed the importance of visual memory and described it as a key aspect for learning and vital in acquiring various academic skills.

The nominal group participants suggested as most important in the weighting for treatment principles should be that content of the computer-based programme is interesting, captures the visual attention of learners and maintains their motivation levels and that it is comprehensible. This aspect received a weighting of 5 and contributed to 20% of the total weighting for visual memory. Fougnie (1998) agreed that visual memory is dependent on visual attention. He found that the amount of information encoded in visual short term memory depends on the ability to discriminate what is seen and the amount of attention allocated and the capacity to understand the stimuli. Therefore providing evidence that adequate visual memory result in quicker and better retention in visual long term memory (Hu et al., 2010). Experts in the nominal group considered this aspect as a high priority due to the challenges that learners diagnosed with ADHD experiences with visual attention. The importance of sufficient visual attention will be discussed in more detail later in this chapter.

Maintenance rehearsal and repetition as suggested from the literature was weighted at four on the intervention criteria checklist for treatment principles. This weighting accumulated to 16% of the total weighting for visual memory. The weighting of this criteria was supported by Miller et al. (2015) who found that 5-9 year old children improved their short term visual memory by encouraging rehearsal strategies. They found that rehearsal training of material presented into-be-remembered material was presented in both auditory and pictorial form, was more effective than using interactive imagery training for memory maintenance. This supports the recommendation of participants for using multiple sensory systems when treating visual memory. Experts felt that that auditory as well as tactile input provided by the computer-based programme could enhance the visual memory and weighted this as the third most important intervention criteria. Incorporating multi-sensory systems for the treatment of visual memory weighted 12% of the total weighting for visual memory. Luck and Hollingworth (2008) reported that when treating visual memory, short and long term visual memory draws on visual sensory memory where the stimulus registers first to consolidate the stimulus into the more stable forms of memory. Fard et al (2006) also showed that sensory learning and multi-sensory stimulation of the visual, auditory and vestibular system significantly increased the visual memory of 7-11 years old learners with learning disabilities (Fard et al., 2014).

Another addition as suggested in the nominal group was that the treatment principles should include exposed to short term and long term memory. This criterion obtained a weighting of one, 4% of total weighting for visual memory. Most research on memory reports on these two aspects and Schneck (2010b) highlighted the importance of long term visual memory activities within an intervention plan due to the effect this has on reading comprehension. Long term visual memory establishes an understanding of the object and concept recognition allowing for quicker and more accurate interpretation of visual material (Schneck, 2010b). These findings were concurrent with the clinical experience of the NGT experts. They reported that they have observed that if learners improved their visual memory, they also improved in their reading comprehension and achieved better results in most of their school subjects.

The grading principle which received the highest weighting was that the length of time needs to be adjusted when presenting visual stimuli so the learners are expected to remember facts and objects more quickly as they advance through the programme. This aspect received a weighting of four, contributing to 16% of the total weighting for visual memory. Experts in the nominal group suggested that providing less time would make the activity more difficult requiring visual memory. Witthaus (2002) agreed and recommended that time over which learners have to remember should be manipulated with less time available as they progress. Experts recommended that a visual strategy such as a countdown timer should be used. This timer should be visible when presenting participants with visual information to recall. Experts reported from their clinical experience they have observed that this strategy assist learners in decision making, planning and facilitate motivation to improve short term memory recall.

Adjusting the amount of visual input to recall receive a weighting of three, 12% of the total weighting for visual memory. Recalling the amount of facts or objects to recall obtained a weighting of two (8% of the total weighting for visual memory). Experts felt these aspects were more complex and should be graded later than the time to recall and the cueing provided.

6.2.4 Visual Closure

The highest rated intervention principle for visual closure was attending to the whole first and then seeing the parts. This intervention principle received a weighting of two, resulting in 50% of the total weighting for visual closure This reductionist approach is important for learning due to recognition of the whole assists a learner to quickly identify objects, shapes and forms by mentally completing the image or matching it with previously stored information (Schneck, 2010a). Recognition of the whole plays a role in encoding of words as applied to the occupational performance skill of spelling (Schneck, 2010b). Experts confirmed the theory of Scheck (2010b) they reported that in their clinical experience they have observed that learners with visual closure difficulties also struggle with spelling and reading. They agreed that seeing the whole first improves the understanding the whole and increase in comprehension improves memory retention as well as the visual closure skill.

6.2.5 Visual Discrimination

For visual discrimination the highest weighting was allocated to the grading principle that allows for differentiation to take place and contains elements of recognition, matching and sorting. This grading principle received a weighting of four and contributed 40% of the total weighting for visual discrimination. Schneck (2010b) confirmed the importance of this weighting by explaining that recognition of individual symbols is required before reading of words or sentences can occur. The element of matching and sorting contributes to differentiate between similar looking letters that differ in spatial orientation such as b/d or p/q (Schneck, 2010b). Experts reported that matching and sorting is a basic skill to master before higher order skills should be introduced. Therefore, the experts allocated the highest weighting for this grading principle to ensure that participants get exposure to it. Thereafter, incorporating activities that allows the identification of similarities and differences received the second highest weighting of three. This weighting contributed to 18% of the total weighting for visual discrimination. Identifying similarities and differences also plays a role in decoding words that have similar symbols but differ in sequence eg. three and there (Schneck, 2010b). Furthermore differentiating between similarities and differences can impact letter formation and handwriting (Schneck, 2010a). Experts reported that participants should first have a basic concept of shapes, letters and numbers before they would be able to identify the similarities and differences. Experts reported in their clinical experience that learners that struggle to identify similarities and differences often presents with reversal and spelling difficulties therefore this criterion obtained a top priority in weighting.

Grading principles for visual discrimination that weighted as most important was to initially identify gross similarities and differences of objects with these graded to smaller similarities and differences (Witthaus, 2002). This grading principle received a weighting of four and contributed to 40% of the total weighting for visual discrimination. Experts consider this grading principle as important because it applies the theory of general grading principles of simple to complex and general to specific. In the computer programme pictures or graphics with bold line and obvious difference should be graded to more subtle and finer lines.

The next most important grading was to increase the amount of similarities and differences between objects as the learners' progress (Witthaus, 2002). This grading principle received a weighting of three and contributed to 18% of the total weighting for visual discrimination. Experts considered this grading principle as important because the more competent participants will become, the more easily they would identify similarities and differences, therefore the more difficult the challenge should become. It would be beneficial that the computer programme visually indicated the number of differences identified with circles and the also the outstanding differences not identified in a numerical format.

Participants in the nominal group recommended that grading principles of general to specific, whole to parts and concrete to abstract to move to the general grading section as these were duplicated under visual discrimination. This recommendation was agreed upon and implemented.

6.2.6 Visual Spatial Relations

When considering treatment principles for visual spatial relations participants felt that is was important for learners to firstly to orientate their own body in relation to objects using the following concepts: " on, under next to, behind, in front , inside, above, between, over, near, far" (Witthaus, 2002):270). This treatment principal obtained a weighting of four and contributed to 44% of the total weighting for visual spatial relations. Experts considered this weighting as important because orientation of spatial concepts assists learners to formulate a mental map of their surroundings. This mental map contributes to planning of motor actions and enables learners to perform activities using their visual perceptual skills. It is therefore a core skill to master and was awarded a high priority weighting. The second most important weighting was to visually scan a page from left to right when engaged in visual spatial relation activities. This intervention criterion obtained a weighting of three and contributed to 33% of the total weighting for visual spatial relations. Experts considered this treatment principle as important because scanning visual information from left to right is an important pre-reading skill and required for successful reading. Experts also reported that based on their clinical experience scanning visual information from left to right is a systematic strategy to ensure that learners do not miss out on important information. In learners diagnosed with ADHD this may also relate to oculomotor function such as disinhibition or an increased percentage of premature saccades as well as an inability plan where to start an activity. It would be beneficial that activities that require spatial relations in the selected computer programme gave specific spatial instructions eg. Left to right and top to bottom in activities that require a person to draw a line from the one dot to the other (dot to dot).

The grading principles for this section were not specific to visual spatial relations and were included under general grading principles.

6.2.7 General principles

General grading of cognitive and visual perceptual development and principles of Framework of Hierarchical Development of Visual Perception

Treatment activities should place initial emphasis on foundational skills in order to ensure that the foundation is solid and thus grading from simple to complex received the highest weighting score in the general grading section. This grading principle received a weighting of five and contributed to 33% of the total weighting for this section. Schneck (2010b) found that simple to complex grading allows success while challenging the skills of the learner. Experts agreed with the findings of Schneck (2010b) they reported that successful participation improves engagement in the activity, furthermore they found from their clinical experience that when applying this grading principle improvement in self-esteem has been observed. Simple to complex grading also assesses competency and enables efficient remediation of skills at various levels (Schneck, 2010b). Witthaus (2002) suggested that this grading principle can be applied when considering sequential development. Therefore Witthaus (2002) recommended that activities that include concepts of size, colour and shapes should take preference before activities that include visual perceptual constructs such as figure ground, visual discrimination. Grading of VMI and thereafter cognition and finally reading and writing activities would be beneficial. Witthaus (2002) recommended that this grading can be applied to an intervention programme by first using symbols, thereafter letters and then words. Primary colours should take preference followed by secondary colours.

Familiar to novel grading principles obtained the second highest score in the cognitive and visual perceptual development section. This grading principle obtained a weighting of four and contributed to 26% of the total weighting for this section. Schneck (2010b) explained that humans formulate a visual image of familiar objects. It is also true that humans may habituate to the familiarity of visual images and therefore decrease their visual attention (Schneck, 2010b). Thus the grading from familiar to novel is essential in maintaining visual attention and thereby reaching therapeutic goals (Schneck, 2010b). Cicchetti and Cohen (2006) pointed out that novel situations or activities elevates cortisol levels in non-anxious and anxious individuals. Therefore, familiar to novel grading should be considered as having a top weighting in the cognitive and visual perceptual section. Experts agreed with the findings from the literature and reported they have experienced success when using the grading principle from familiar to novel activities. Experts further explained that this grading principle is also useful when revising activities before introducing a new activity it therefore aids remediation of skills.

The learning principle that scored the top weighting was motivation to engage and complete tasks (Mosey, 1986). This intervention principle obtained a weighting of four and contributed to 40% of the total weighting for this section. Experts reported that they found from their clinical experience that motivation plays a key role in the learning process. This was confirmed by Witthaus (2002) she stated that motivation has been linked to the limbic system and impacts on learning and memory. Buckle et al. (2011) found that learners diagnosed with ADHD often present with poor in-seat behaviour and that results in not completing their tasks. The aspect of poor task completion was confirmed by the American Pscychiatric Association (2013) they reported that learners diagnosed with ADHD have difficulty in completing tasks due to poor sustained attention, hyperactivity and poor in-seat behaviour. Motivation was also an important aspect highlighted by the Dynamic Systems Theory.

The second highest weighted learning principle was that activities should be selected based on age, gender and reflects a learner’s interest. This principle obtained a weighting of three and contributed 30% of the total weighting for this section. Schneck (2010b) reported that appropriate activity selection will ensure active participation and reduce activity limitations. Experts suggested one way to ensure the programme meets this criterion to ensure that the programme is theme based. They recommended that a general theme such an animal themes could be appropriate for children between the ages of 7 to 9. Experts highlighted that the importance of this aspect and they reported that this aspect might contribute to the motivation and successful engagement of participants in activities.

6.2.8 Dynamic Systems Theory Model of Visual Perception

Participants in the nominal group were not familiar with the application of DSTMVP to visual perceptual intervention. After explaining the DSTMVP to them, they agreed that it is essential to include in an intervention programme. Interventions criteria were voted on and weighted for each of the subsections of the DSTMVP. Each subsection of the DSTMVP was viewed and rated individually due to the interactive process of the DSTMVP. Each subsection therefore had an equal chance of receiving a weighting.

6.2.8.1 Goal

The top weighted intervention criterion in the goal subsection of the DSTMVP was that activities need to be goal directed. This aspect received a weighting of two and contributed to 50% of the total weighting for this section. Yoshikawa (1993) described the importance of activity goals as independent to therapeutic goals. Activity goals are viewed as a facilitating function to achieve therapeutic goals (Yoshikawa, 1993). Case-Smith (2015) agreed and elaborated that therapeutic goals can be establishing in collaboration with the child and act as a motivator to enhance performance.

6.2.8.2 Early Visual Processes

Activities that include visual memory received a weighting of one and contributed 100% to this section. As with the specific visual perceptual components activities that involve visual memory were the highest weighted intervention criterion in this subsection of the DSTMVP. The importance of visual memory has been discussed above and it was felt that activities that remediate visual memory would assist learners diagnosed with ADHD to dynamically adapt visual images and therefore contribute to the neuroplasticity of new experiences (Lauwereyns, 2012). This supports the importance of visual memory for early visual processes and development described in the DSTMVP.

6.2.8.3 Tactile and proprioception

The inclusion of a tactile element in the computer programme was weighted as the highest criterion in this section. This aspect received a weighting of two and contributed to 50% of the total for this section. In the description of the DSTMVP the importance of including tactile and proprioceptive components to activities when treating visual perceptual skills is emphasised. The computer-based programme should include both components. Experts thus suggested that the operation of the programme should include the use of the touchpad of the laptop computer to move the arrow and left or right click to select.

6.2.8.4 Attention and knowledge

The importance of activities to attract visual attention scored the highest weighting in this subsection of the DSTMVP. This aspect obtained a weighting of two and contributed to 50% of this section. Literature has confirmed that learners diagnosed with ADHD have poor visual attention (Loe and Feldman, 2007; Kurtz, 2006). Therefore, this element is important to consider. Wolfe and Horowitz (2004) pointed out that colour, motion; orientation and size are primary guiding attributes for visual attention. While shape is not as important but also plays a role in maintaining visual perception. The computer programme should therefore contain these attributes for learners to maintain visual attention (Wolfe and Horowitz, 2004).

6.2.8.5 Language and culture

The highest weighting in this subsection of language and culture was that auditory instructions should be presented in language of learning and teaching. This aspect received a weighting of two and contributed to 50% of the total for this section. Visual and auditory input and the two primary sensory receptors that provide information (Lane, 2002) Furthermore auditory instruction will also assist in maintaining the sustained attention of learners diagnosed with ADHD. Goldstein and Goldstein (1998) recommended that reinforcement of instructions should occur in learners diagnosed with ADHD. Experts suggested that reinforcement of instructions could be to provide instruction on both an auditory and visual level. Ayers and Robbin (2005) reported that development of brain stem processing is important for discriminating visual and auditory processing. They also said that visual processing in brain stem functions provide the foundation for complex, higher level functions required or language. Furthermore, there are strong research evidence to support the relationship between ADHD and auditory processing disorder (Stavrinos et al., 2018; Chu and Reynolds, 2007). Therefore, the combination of auditory instruction with visual images will assist in remediation of skills.

6.2.8.6 Posture and movement

The highest weighted criterion in the posture and movement section was that activities should allow a stable base of support. This aspect obtained a weighting of two and contributes to 50% of the total weighting for this section. A laptop computer is recommended due to the controlled variable of distance from eyes to screen, stable base of support and if a learner is seated at a table it is possible to facilitate correct seated posture. Smith Roley and Schneck (2001) pointed out that head position can impact on sensory integration. Head position activates the vestibular system and can impact on the activation of oculomotor muscles. Head position can have an effect on auditory processing, movement and vision. Blyth (2015) reported that correct seated posture is essential for concentration, endurance and reducing musculoskeletal pain. It is therefore suggested that a good seated posture could be maintained during the activity with minimal head tilt. This intervention criterion is therefore important for learners diagnosed with ADHD in aid of facilitating concentration skills. Experts reported that facilitation of good posture during the intervention will also assist participants in awareness of functional posture during classroom activities and might play a role in VMI or copying activities.

6.2.8.7 Retinal image

The retinal image criterion that obtained the highest weighting was that activities should allow recognition of objects to stimulate the foveal vision. This aspect achieved a weighting of two and contributed to 50% of the total for this section. In order for recognition to occur a mental representation of the object is required (Cavanagh, 2011). Experts suggested that they have observed that learners display better comprehension of familiar objects and this might be attributed to stimulation of foveal vision which is consistent with the literature (Cavanagh, 2011). Furthermore, repetition and scaffolding of familiar activities would play an essential role. Therefore, confirming with importance of the familiar to novel grading and visual as previously discussed.

6.2.8.8 Motivation and emotions

The top weighted criterion in the motivation and emotions section was that positive reinforcement should be included to elicit a positive emotional response. This aspect obtained a weighting of one and contributed to 100% of the weighting for this section. Various studies found that learners who are encouraged often have better intrinsic motivation and perform better in academic tasks (Gottfried et al., 1994; Kotaman, 2018; Guéguen et al., 2015). Shizgal and Hyman (2013) confirmed and elaborated that motivation has neurological reinforcement involving neuromodulators and neurotransmitters. This neurological process plays a role in attention and goal attainment that contributes to long term memory. Experts therefore suggested that positive reinforcement should have a constructive impact on learners diagnosed with ADHD. They recommended that positive reinforcement could be applied computer software by providing positive auditory or visual feedback upon recording the correct response.

6.2.9 Guidelines when using activity worksheets or graphic material to reduce visual distractibility

Using high contrast images with distinct boundaries scored a weighting of six in the section of guidelines when using worksheets or graphic material. This principle contributed to 33% of the total weighting for this section. Yao (2017) reported that high contrast images tend to be sharper, richer and contribute the comfort of human visual perception. Friedenberg (2013) found that high contrast images are contributing factor in increasing visual attention although not as important as colour orientation and size (Theeuwes and Kooi, 1994). Therefore, this intervention criterion is important to consider in the intervention planning of remediating visual perceptual skills in learners diagnosed with ADHD.

The second highest weighting for criteria in this section was to organise items that go together next to each other. This aspect received a weighting of five and contributed to 27% of the total weighting for this section. This criteria will assist learners in developing sequential processing (Schneck, 2010b). Elements that belong together will be divided into groups and structured together. For example, all items that belong in the kitchen are grouped in one table. It will also assist in compensating for visual memory difficulties. Similar items that are grouped together will also contribute to the similarities and differences intervention principle of visual discrimination (Schneck, 2010b).

6.2.10 Important elements of a computer programme for the remediation of visual perceptual skills in children diagnosed with ADHD

6.2.10.1 Feedback and motivation

Level of difficulty should be adapted to the participant's level of skill obtained the highest weighting of three and contributing to 50% of the weighting for this section. Various levels of skills are important factors that determine the success and motivation of a learner (Schneck, 2010b). It is imperative that a learner achieve a feeling of mastery but also experience the just right challenge to stay engaged in activities (Lane, 2002; Ayers and Robbin, 2005; Smith Roley and Schneck, 2001).

6.2.10.2 Instructions and description

The top weighted criterion in this section was that instructions should be presented by visual and auditory input. This aspect obtained a weighting of two and contributed to 50% of the total weighting for this section. It has been discussed in the language and culture section of the DSTMVP. This weighting therefore validates the importance of this section to the remediation of visual perceptual skills in leaners diagnosed with ADHD.

6.2.10.3 Monitor progress and outcomes

The programme should consist of a login system where personal information is stored obtained the highest weighting in this section. This aspect obtained a weighting of three and contributed to 50% of the total weighting for this section. Limited literature was available on this aspect. Experts reported that due to the discussion in the feedback and motivation section it would be considered that this aspect could contribute to differentiate according to the level that the learner is on. It would therefore be beneficial if a leaner can continue on the same level that he/she completed during the previous intervention session, therefore a login system is essential.

6.2.11 Selection of an appropriate computer programme for the remediation of visual perceptual skills in leaners diagnosed with ADHD

The availability of computer-based software to review was disappointing as there was a limited range of programmes available on the South African market that consider visual perception. Additionally, the investigator was not able to obtain any funding for this research project, therefore had to select programmes that could be obtained through self-funding. The software that was used in previous research was from international sources and were outside the price range of this study. The programmes that were reviewed are therefore realistic in terms of parents', therapists' or schools' financial capabilities. The *Sea World Adventures™ and Cami Perceptual Skills Builder*™ were identified as suitable programmes and were reviewed for the selection of appropriate computer programme for the remediation of visual perceptual skill in learners diagnosed with ADHD.

The intervention criteria and computer software evaluation form assisted with making objective decisions regarding the selection of an appropriate computer-based software for the remediation of visual perceptual skills. It was structured and the quantitative aspect of the weighting contributed in eliminating bias. It also created a clear understanding between the researcher and expert in the field to determine what aspects to consider. The intervention criteria and evaluation form assisted in providing a transparent tool for evaluating computer programme software. The *Sea World Adventures*™ programme achieved the highest rating (84%) using the intervention criteria evaluation form.

The strengths of the *Sea World Adventures*™ perceptual programme in terms of content are that is covered all four visual perceptual components identified as having impairments in learners with ADHD in Phase 1 of the study.

In terms of important elements of a computer programme for the remediation of visual perceptual skills in children diagnosed with ADHD feedback, monitoring and motivation principles were embedded as feedback was always provided in a positive nature. Correct responses receive positive feedback for example “you are a star, well done; you are clever, good job”. Incorrect responses receive neutral but encouraging feedback for example “better luck next time, try again, you can do it, keep on trying.

Feedback was also given in terms activities so the learner knows how many responses are required which plays a positive role in motivation and improves learning. The feedback allowed the learner to track their own progress in each activity and a level in which they were able to succeed.

Instructions in the programme were verbal and visual and simple so participants were able to comprehend what is expected of them. Activities with auditory input assisted with the improvement in visual memory. This aspect is important when considering literacy development when an integration of visual and auditory input is required. In the visual discrimination the use of lower case alphabet is also appropriate because according to the CAPS curriculum they first learn lowercase before mastering uppercase in South African schools. Activities also required construction of lines from left to right and top to bottom. This facilitates visual screening from left to right and is an important pre-reading skill.

In line with general hierarchical treatment principles based on the theories of Piaget and Mosey the *Sea World Adventures*™ perceptual programme provided. As indicated above, feedback was provided influencing motivation which was also supported by the interactive nature of the activities as the correct level of difficulty. Repetition was supplied by repeating activities until the level was mastered. All the different visual perceptual components were graded according the all the criteria of simple to complex, familiar to novel, general to specific and whole to parts.

6.2.11.1 Other aspects that was included in the Sea World Adventures™ programme

The *Sea World Adventures*™ programme contained 100% of the criteria as identified in the DSTMVP section. Aspects mentioned in the visual memory section contributed towards the activation of early visual processes of the DSTMVP.

Tactile and proprioception was addressed by the touch pad that required the learners to click and drag icons to spatial locations. The images and icons were also presented in various colours and sizes. This aspect played a role in capturing and attracting the visual attention of participants. The octopus (game guide) is animated and moved across the screen from left to right and positioned on the right side for the duration of the activity presenting instructions and feedback. The animation feature of the *Sea World Adventures*™ programme assisted with the facilitation of retinal image by the movement and diversity of spatial locations. Furthermore it might have assisted in capturing and maintaining the visual attention as well as visual tracking skills.

Each activity had a clear goal that motivated the participants to succeed and various therapeutic goals were met in each activity (Appendix Q). The activities had various levels and embedded grading facilitating the improvement of skills. Various levels were visually presented in the bottom right corner and progress in the current level on the top right corner. This assisted with motivation and task completion. Aspects of feedback have already been addressed but also contributed to motivation levels of participants.

The laptop devices provided a stable base of support and enabled research assistants to facilitate a good seated posture resulting in participants' better attending to the task at hand. The portability of the laptop devices enabled controlling environmental factors that could impact on visual distractibility. Research assistants were instructed to place the laptops next to a wall and away from windows or doors to reduce distractibility of outside elements. Distractibility was also reduced by grouping items that belong together next to each other. Furthermore, distractibility was controlled by only revealing the required visual object on the screen and not cluttering the screen with irrelevant information.

The computer programme report generation is also strength of the programme as a quantitative measure of what activities participants have mastered and in what areas they need more practice. Another advantage of this report is that the time spends on each activity can be monitored and impulsive behaviour identified. This report will be a useful monitoring tool for clinicians should be programme be used as an individual support intervention in class or at home. The report is also beneficial for the participants as it can be shown to them to see their progress and this can be a motivational aspect.

6.2.11.2 Intervention criteria that was not included in the Sea World Adventures™ programme

In the visual memory section of the intervention criteria two aspects were not well included or well presented in the *Sea World Adventures*™ programme. Firstly long term visual memory was not present in the visual memory sections and secondly the manipulations of time aspects were not visually present. The lack of visual timers might have impacted on motivation levels or improvement of skill.

A limitation of the *Sea World Adventures*™ programme in terms of discrimination was activities could not be graded from 2D to 3D due to the graphic restrictions of the computer programme. Future *recommendations* as discussed in Chapter 7 include the use of virtual reality or 3D technology to include these aspects.

In the general principles section grading from personal to worldly lacked. These aspects can possibly be included in future by adding a photo of the participant to the programme to be used as an icon and required to complete certain activities. This grading can be extended to pictures imported to the programme of classmates or familiar objects in the classroom that becomes part of the game.

In the section of monitoring progress and outcomes the *Sea World Adventures*™ programme lacked a detailed login system containing personal information such as date of birth (calculating chronological age), medication, class and other important information. Accounts were also not password protected therefore not securing the reporting section. In the scoring section it indicates percentages for each activity and time spend on each activity. Graphs could be a future recommendation to also assist with facilitation of motivation due to the visual nature of statistical graphs.

6.2.12 Conclusion

Integration of literature and clinical reasoning was required in order to develop a an intervention criteria to provide fidelity for the intervention used in Phase 3 (Law and Mac Dermid 2014). Systematic grading principles required to guide treatment in a meaningful manner and to challenge the participant to master skills were confirmed and weighted in the nominal group. The limited number of computer programmes that could be reviewed was disappointing and it had been anticipated that more programmes would be available. This may have had an influence on Phase 3 of the study and other programmes should be evaluated in future. After an appropriate computer programme had been selected, the programme was tested in Phase 3 to determine the effectiveness of the programme on the visual perceptual functioning of 7-9 year old learners diagnosed with ADHD.

6.3 DISCUSSION - PHASE 3

6.3.1 Introduction

The discussion will consider the demographics of the sample as well as the implications of the results of the between and within group results in relation the interventions used in the crossover research design. The change in scores in the Beery VMI, TVPS-3 and scholastic achievement will be considered within each of the groups and between the groups for the three assessment periods.

6.3.2 Demographics of participants

The sample size of 50 participants was adequate for statistical analysis and achieved statistical significance for both Group 1 and 2, with a sample size of 25 participants each. However, higher confidence in the results would be obtained if a larger sample size had been used. Therefore, replicating the study using a larger sample size would be beneficial.

The gender distribution in this study of 68% males is supported by the National Center for Health (Bloom et al., 2009) in the United States, which released statistics that revealed boys were nearly twice as likely to have ADHD than girls. The population distribution of the participants in that study was not representative to that in South Africa. In this study 80.8% of participants were Black African and only 7.9% White African (Stats SA, 2017). This data was compared to 85% of White African people. The sample however was representative of the demographics of the learners at the LSEN school based in a urban environment and where the language of instruction in the foundation phase was Afrikaans rather than English. The participants fell into the expected age range for learners in the foundation phase of education (Grade 1 – Grade 3) and these learners were targeted for this study as literature emphasises that the critical age for perceptual development is between the ages of 7 to 9 years (Schneck, 2010b; Vlok et al., 2011a) (Table 5.1). These demographics might have impacted on the improvements observed in the results due to early identification of barriers to learning that occurred for these learners, as well as the intervention and support from the school. The school is located in an urban area and most of the participants came from middle class families. Therefore, the majority of participants had been introduced to technology prior to the study. This might have had a positive impact on the results because learners were not anxious about engaging in computer activities and they were interested in participating.

Participants were taking various medications for attention deficit and the majority had been prescribed methylphenidate (Table 5.2), which is the medication mostly commonly recommended in the management of core symptoms of ADHD due to the stimulant nature (Papavasiliou et al., 2007). The medication use of the participants was monitored, as Papavasiliou et al. (2007) evaluated the effect of psycho-educational training and stimulant medication on visual perception of children with ADHD and found that those taking stimulant medication achieved better post-treatment outcomes in visual perceptual subtests of the TVPS-R (Papavasiliou et al., 2007). (Conners 2002) reported that children taking methylphenidate medication improved motivation, drive and productivity. The effect of medication in the current study was not analysed as only six participants were not on medication and the sample was too small to make any conclusions. The participants who did not take medication were equally distributed between Groups A and B, which mitigated to some extent this possibly interfering variable.

6.3.3 Multimedia behaviour

Children born in the 21st century are exposed to multimedia devices (smartphones, laptops, desk top computers, tablets, hand held game consoles) from a young age. Limited literature is available on the use of computers under the age of three, and since the participants of this study came from different backgrounds, exposure to technology was diverse. Laptop computers were the only platform used where complete visual perception interventions programme with all the components met the requirements. This presented a problem initially as only 14% of the participants had previously had access to laptop computers. The research assistant occupational therapists reported that these learners took a few sessions to learn how to use the laptops, as they were unfamiliar with them. Observations were also made that participants with poor fine motor abilities initially found it difficult to drag objects from one area to another, but after a few sessions, they were able to do so.

6.3.4 Duration of exposure to multimedia devices

Participants of this study engaged in multimedia behaviour daily, often more than twice a day. Adverse behaviour has been associated with overexposure to screen time. Hale and Guan (2015) reported that screen time had a negative impact on sleep outcomes in 90% of studies they reviewed. They found that screen time can shorten the duration of sleep or delay it, as well as affecting communication and social skills (Hale and Guan, 2015; Christakis and Zimmerman, 2007; Van den Bulck, 2004). However, the advantages of electronic media can be valuable and assist to improve educational outcomes. A recent study pointed out that appropriate selection of screen intervention can have a significant impact on executive functioning and working memory (Huber et al., 2018).

The American Academy of Pediatrics recommends that screen time of children older than 6 years should be monitored and not replace time allocated for sleep, physical activity or behaviour essential to health (American Academy of Pediatrics 2016). Screen time varied from day to day depending on their routine. The average amount of screen time was between 5 minutes and 2 hours, which falls into the recommended average for 5 to 12 years olds (Department of Health and Ageing, 2004).

Parents reported that participants of this study did not to engage in any new games of multimedia activity as requested. This request was to eliminate any external factors that might have an impact on their visual perceptual skills and to reduce the risk of overexposure to screen time.

6.3.5 Effects of a computer-based and routine intervention on visual perception

Visual perception is a core skill required for academic learning (Schneck, 2010b; Vlok et al., 2011a; Coté, 2015; Poon et al., 2010). Children diagnosed with ADHD often have weaker visual perceptual skills compared to typical peers due to poor visual attention and impulsivity (Loe and Feldman, 2007; Kurtz, 2006). They also find it difficult to filter out irrelevant environmental stimuli and therefore fluctuate in terms of visual attention skills (Schneck, 2010b). Lack of a strong visual perceptual foundation and ADHD associated symptoms related to weaker academic performance than typical peers and which can affect their self-esteem, may present as behavioural challenges in the classroom (DuPaul et al., 2013; American Pscychiatric Association, 2013). Routine intervention, including occupational therapy and remedial teaching, has been widely used effectively to remediate these barriers to learning (Abreu and Toglia, 1987; Neistadt, 1990; Warren, 1993; Schneck, 2010a; Schneck, 2010b).

Computers have become a common therapeutic medium in occupational therapy over the last two decades (Ross, 1992; Wuanga et al., 2018; Chen et al., 2013; Halton, 2008). Results of the current study yielded sufficient evidence that computer-based visual perceptual interventions, under the guidance of an occupational therapist, can also assist with the remediation of visual perceptual barriers to learning in children diagnosed with ADHD, allowing for rejection of the null hypothesis in this phase of the study. The visual perceptual skills of 7 to 9 year old learners diagnosed with ADHD did improve significantly when using a computer-based visual perception and routine intervention (Intervention A) compared to routine intervention only (Intervention B). Nakashima and Shioiri (2015) recently found that head position has an impact on visual perceptual skills and attention modulation. Their findings suggested that head direction is associated with attention modulation and it can impact on visual perceptual skills. Findings of this study reported people attend better to visual stimulus that is straight ahead of them due to central fixation bias. Their findings therefore suggest that a vertical surface of a computer screen could be more preferable for visual perceptual remediation than a desk top worksheet.

This hypothesis was supported by of the results for the Beery VMI and TVPS-3, which accommodated the developmental progress of each participant, as the standard scores used were norm based and compared the participants to typical children of the same age. Participants improved significantly in all areas of Beery VMI test, TVPS-3 and scholastic assessments after the computer-based visual perception and additional routine therapy in Intervention A for both Group 1 and Group 2. When the z scores were considered after intervention A, all participants showed a change equivalent to 1SD with the z scores close and below -1 (indicating a need for intervention) to an improved z score of 0 (indicating performance in the typical range). The change in scores after Intervention B of routine therapy alone were smaller and did not result in a similar 1SD change, indicating less improvement on the of Beery VMI test, TVPS-3 tests. It is therefore evident that Intervention A was effective in reducing developmental delay in visual perception and VMI in the intervention period of 10 weeks.

6.3.6 Visual perception functioning

The first objective of the study was to determine the change in visual perceptual functioning due to computer-based and routine interventions and routine intervention alone for 7 to 9 year old learners diagnosed with ADHD.

The scores on the Beery VMI test were used to assess visual-cognitive and visual motor aspects and the TVPS -3 used to assess basic processing, sequencing and complex visual perceptual processing (Martin 2006).

The scores for the visual perceptual supplemental test on the Beery VMI and the composite scores and total score on the TVPS-3 showed highly significant improvement for the participants of both Group 1 and 2 in Intervention A, the computer-based and routine intervention. This indicates the effectiveness of this intervention compared to Intervention B, routine intervention alone, for the visual perceptual scores on the Beery VMI test achieved by Group 2 when they received routine therapy only in the first 10-week period, and the small improvement for visual perception was not significant.

The significant change in the standard scores on the TVPS-3 for Group 2 at this stage indicate that the routine intervention provided did result in some improvement in the visual perceptual skills assessed by the TVPS-3. The change in scores over these 10 weeks was small and the scores still indicated the need for therapy as they fell at z scores of -1 or less. The positive change in these scores was approximately five times greater for Intervention A, confirming the effectiveness of the computer-based and routine intervention.

In Group 1, the improvement that occurred in Intervention A, the computer-based and routine intervention, was also highly significant for the Beery VMI and the TVPS-

3 in the first 10-week period. These participants achieved z scores in a typical range after Intervention A and no significant improvement was seen for their TVPS-3 in the second 10 week Intervention B except for the overall TVPS-3 score. This indicated the participants maintained the gains made in Intervention A, and although routine intervention alone did result in some further improvement, this was limited. The results for Group 1 further confirm the effectiveness of Intervention A and that improvement achieved during this intervention is maintained when the computer-based programme is withdrawn.

The significant improvement in some TPVS=3 scores during Intervention B indicate that routine therapy alone has a greater effect on and is probably aligned with the components of visual perception assessed by this test and did not support change in the visual perceptual scores assessed on the Beery VMI. This finding is congruent with that reported by (Harris, 2017), which indicate that the visual perceptual skills assessed by the TVPS-3 and the Beery VMI test differ and cannot be considered interchangeable (Harris, 2017).

The effectiveness of computer-based intervention for visual perception in this study is supported by Poon et al. (2010), who found the use of the computer-based intervention was effective in improving visual perception significantly in children identified with visual perception deficits, although their study did not consider learners with ADHD specifically (Poon et al., 2010). The findings also correlate with a recent research study conducted by Wuang et. al (2018), who developed a Game-Based Auxiliary Training System (GBATS) and tested its effectiveness on treating visual perceptual skills. They found that improvement on the total score of TVPS-3, when assessing participants visual perceptual skills as well as improvement in adaptive behaviour, related to school functions (Wuanga et al., 2018). Other research has shown the effectiveness of computer-based visual perceptual intervention for children diagnosed with developmental delay and cerebral palsy (Poon et al., 2010; James et al., 2015).

Other visual perceptual functioning assessed on the Beery VMI test included fine motor ability and integration of the visual cognitive and motor systems. According to the within group results, highly significant differences were achieved for both groups when receiving computer-based visual perceptual intervention and routine therapy

(Intervention A). These scores fell slightly below the mean of 100 for this test and improvement was less than that achieved in the visual perceptual supplemental test.

The change in VMI and motor coordination supplemental test standard scores for Group 2 were not significant, indicating small improvement in this group when receiving 10 weeks of routine therapy alone. In Group 1 however, once they had achieved highly significant improvement in the first 10-week period with Intervention A, significant improvement was seen for their VMI in the second 10 week Intervention B. This indicated that once this group had achieved improvement, which placed their VMI scores into the typical critical range above a z score of-1 and closer to a z score of 0, it appears they maintained their initial improvement and were able to use this ability to further improve significantly with routine intervention alone. It must be noted that the improvement, although significant, was smaller than that achieved in Intervention A, indicating possible slower progress but confirming that further practice improves motor skills that have been developed and consolidated.

Data analysis revealed that VMI and motor coordination assessed on the Beery VMI test improved significantly with Intervention A, thus it appears that the computer-based intervention can be considered effective for these components related to visual perceptual functioning as well. The improvements in VMI are more likely related to the overall improvement in visual perception rather than the improvement in motor coordination, as motor coordination did not improve significantly for Group 1 in Intervention B. The improvement in the VMI and motor coordination, while significant, were less than that found for visual perception since these were not the primary outcomes targeted by the computer programme. The significant improvement in motor function during Intervention A was not however unexpected given the motor component required for the computer-based intervention.

This confirms the use of the Dynamic Systems Theory Model of Visual Perception approach, where movement in conjunction with other visual perceptual input to achieve a goal supports the development of motor function because the motor system is integral to the development of visual perceptual skills. Noë (2004) argues that in the brain, visual perception is inextricably linked to how the motor system would act (Noë, 2004). This confirms the value of the computer programme used, as it required the use of a touch pad, and drag and click actions in line with the action and visual images on the screen. These actions require finger control and limb coordination, in conjunction with eye movements and spatial and direction components associated with visual perception (O'Brien et al., 2010). It appears that the skills developed during the computer-based intervention were transferred back to the pen and pencil medium used when administering the VMI and motor coordination assessments of the Beery VMI test.

The findings of the current study were contrary to those of Poon et al. (2010) who investigated the effectiveness of a computerised visual perceptual programme on VMI to improve Chinese handwriting. They found non-significant deterioration in VMI after using a computer-based programme for eight sessions even though their computer intervention included a fine motor component. Their participants had a z-score of below -1 for visual perception at the start of the study and, as in the current study, continued with normal classwork. However, while the participants in the current study only used different motor skills once a week during Intervention A, the participants in the study by Poon et al. (2010) continued with the computer-based intervention at home. This indicates their participants had a more intensive period of computer-based intervention, which did not reflect in any improvement on the paper and pen based VMI test after the intervention. The difference may be accounted for by the 20 intervention sessions in this study compared to the eight in the study by Poon et al. (2010). The longer intervention phase assisted with the improvement in VMI and motor coordination. The consolidation of slow motor skill learning for complex skills such as these has been shown to be dependent on changes in both white and grey matter in the brain, which are related to the amount of practice provided (Dayan and Cohen, 2011).

The effectiveness of the use of the computer programme can be aligned to the constructs of the Dynamic System Theory Model of Visual Perception (Coté, 2015). The use of this medium to present visual perceptual information does not target specific components of visual perception in a hierarchical fashion, but recommends therapy for specific visual perceptual deficits using table top activities and worksheets as well as movement activities (Schneck, 2010b).

The computer-based intervention provided the participants with many interconnected components in a visual task centred on the task goal which supports the DSTMVP

(Coté, 2015). Each participant’s developmental was considered without taking into account the hierarchical nature of visual perception, and intervention into the computer programme was according to the participant’s level of assessment. Each aspect of the programme provided the participants with an attainable and clear goal to achieve. This is congruent with the umbrella components of the DSTMVP, which assumes a change in visual perception based on the constructs of attention and knowledge by attaining a goal in an activity (Coté, 2015). The computer programme provided interaction and facilitated the dynamic relationship between attention, knowledge, motivation, language, tactile, proprioception, movement, early visual processes and retinal image, which contributed to the success of the intervention according to the criteria established in Phase 2 (Chapter 4).

‘Knowledge’ or perceptual learning increases with experience and practice thus an intervention period of 10 weeks was used with both interventions. The computer-based programme did provide an appropriate level of stimulation for each participant, based on the ability to facilitate this process within the environment. The various levels in the programme, which assumed knowledge from previous levels, allowed the participants to recognise how new information related to previously acquired knowledge (Schneck, 2010b).

Since attention is one of the factors that plays a role in visual perceptual deficits in children with ADHD, using appropriately selected computer-based tasks was more likely to result in their successful goal completion due to adequate attention and task participation. To ensure attention and the possible resultant improvement in learning and cognitive function was facilitated (Coté, 2015), Intervention A was presented to reduce distraction. Selective attention, allowing focus attention on relevant stimuli while ignoring irrelevant stimuli at any given point in time, was accommodated by the use of earphones to provide auditory instructions and the elimination of visual and auditory distractions in a quiet room (DeShazo Barry et al., 2001). Since sustained attention or the ability to be focused by a stimuli and remain focused over time (DeShazo Barry et al., 2001) needs to be further facilitated in children with ADHD, the therapeutic medium in the computer programme was selected to be interesting and appealing to participants by providing tasks that could be considered intrinsically rewarding. Elements of the computer programme that provided immediate extrinsic rewards were the various levels for each activity, the visual icons to indicate progress and stars for correct responses. According to Marx et al. (2018), providing rewards may assist with poor impulse control that is prevalent in children diagnosed with ADHD and may also improve task completion and accuracy.

Increased motivation levels could be attributed to positive auditory feedback received from the programme and progression of various skill levels offered. In addition to the rewards, words of encouragement to motivate participants to attempt the activities in the computer programme were provided by the research assistants using a positive label and predicting success prior engagement in the programme (e.g. “I am sure you will succeed”). There was also positive reinforcement throughout the intervention session in the form of auditory feedback provided from the computer programme even if the participant did not get it correct the first time. Words such as “good try,” “well done,” “good job,” you`re clever” were used. The effect the use of verbal encouragement and reinforcement has on learning has been reported as positive (Guéguen et al., 2015; Bickers, 1993; Isenberg and Bass, 1974; Miller et al., 1975), with a recent research study reporting that receiving verbal encouragement resulted in 82% of children in an experimental group succeeding compared to 47% of children in the control group (Guéguen et al., 2015). Additional improvement in motivation might improve attention due to retinal image activation and interest of participants engaging in technological occupations.

It was reported that the participants persisted and none of them gave up or refused to attempt the activities, indicating these measures were effective in motivating participation in children with ADHD who often, due to previous failures, are not willing to attempt activities in which they know they may not succeed (Hoza et al., 2001). Encouragement and positive reinforcement were thus a key aspect in the success of the computer-based intervention.

Instructions and encouragement were provided in the language of teaching and learning. Language is an important aspect in learning visual concepts and is also related to attention and therefore allows goal attainment (Coté, 2015). Dessalegn and Landau (2013) highlighted that children between 3 and 6 years of age improved their attention to task and visual memory skills when accompanied by auditory instructions.

Proprioception and touch were other components in the DSTMVP linked to facilitation of visual perception enhanced by the computer-based programme. Using the touchpad and providing input by means of clicking and dragging objects was required to attain the feedback and output. Vision and touch are closely linked and bring about learning experiences from an early age (Cermak 2006; Raskin and Baker, 1975; Lane, 2002). The movement process also required an integration of cognitive concepts such as spatial visualisation, spatial orientation, motor planning, eye/hand coordination and motor planning that enhanced the learning process.

Visual perceptual input did change based on experience, as the different levels in the computer programme offered interaction with various visual perceptual constructs such as visual discrimination or visual closure. All the components of visual perception were combined with interrelated tasks which facilitated intentional visual activity and that were relevant to the participants (Coté, 2015; Gilbert and Li, 2013; Lauwereyns, 2012). This allowed vision and the use of early perceptual processes to support “knowledge’ or information processing in the visual-perceptual–motor domain essential for academic achievement (Schneck, 2010b).

Although movement was limited in terms of the computer-based programme, it was addressed by animations on the screen that elicited ocular movements. The importance of ocular motor movements and the role that this plays in the vision process has been highlighted (Schneck, 2010b). Voluntary eye movements were facilitated by the movement of colourful animations on the screen by throughout the computer-based sessions. Fine motor movements of the fingers were also facilitated by the use of the touchpad on the computer in response to visual input, facilitating visual motor integration. This is supported by the results, which indicated that the motor coordination skills of participants improved in the within group results of the Beery VMI assessment.

As with the current study, research has shown that computer-based interventions can enhance children’s attention and are a suitable intervention for inattentive, at-risk children such as those with ADHD. Children diagnosed with ADHD have been found to experience over or under responsivity to sensory input (Coté, 2015) with the resultant inadequate sensory modulation associated with distraction and an inability to focus attention consistently.(Lane, 2002; Ayers, 1979). The influence the computer programme might have on sensory modulation was not part of this study but should be considered in future. This would include the brightness of display settings that could be changed and other tactile input to achieve feedback.

The alternative hypothesis, agreeing that visual perceptual skills of 7 to 9 year old learners diagnosed with ADHD will improve significantly when using a computer-based programme in collaboration with routine intervention, will be accepted.

Although the changes in visual perception functioning were significant, it was important to determine the carryover, if any, of this improvement to the participants occupational performance in academic achievement ,as this is the outcome at which addressing visual perceptual deficits is aimed.

6.3.7 Effect of a computer-based and routine intervention on academic functioning

The second objective of the study aimed to determine the change in academic functioning resulting from the computer-based and routine interventions and routine intervention alone for 7 to 9 year old learners diagnosed with ADHD.

When the academic functioning in reading, addition and subtraction were considered, as expected the results showed highly significant improvement for both groups for Intervention A and Intervention B. This was not unexpected, as these learners continued with school-based academic programmes in the classroom throughout the study.

When reading was considered, the results for Group 1 after Intervention A and having received the computer-based and routine interventions, showed an improvement of their reading level by 12 months in age, according to age norms on the test, whereas the improvement of their reading level improved by 3 months in age after Intervention B. Although this may indicate that the improvement in visual perception during Intervention A had an effect on their reading, Group 2 also improved their reading level by 5 months in age during Intervention B where they only received routine intervention. During Intervention A, the change in scores continued and they improved their reading level by a further 7 months in age. Although it appears that both groups made greater gains in reading during Intervention A, this could be linked to the improvement in their visual perceptual skills and it must be accepted that the effect is limited as other factors play a role in learning to read. These findings support the premise by Schneck (2010b), that children diagnosed with ADHD often have challenges with reading due not only to poor, inadequate visual perceptual skills, but also visual attention and impulsivity. Since deficits in visual perception are associated with difficulty in orientation of words, recognition of letters, delineation of characteristics of printed information, sequencing, decoding and working memory, assessments of these components of reading rather than speed alone may have provided more insight into the effectiveness of the computer-based intervention.

Rabiner et al. (2010) found that computer-based interventions may result in longer-term benefits for children with more extreme attention problems in terms of reading skills was disproved in this study, as Group 1 did not continue to improve at a similar rate in Intervention B and in fact, both groups achieved equivalent scores at the end of the two intervention periods.

A correlation between the perceptual function in terms of VMI and motor skills and academic outcomes of learners have been found, with visual motor integration in particular having a strong association with academic achievement (Vlok et al., 2011a; Schneck, 2010b; Martin 2006). Sortor and Kulp (2003) found a significant correlation in the VMI and motor coordination sections of the Beery VMI test with the Stanford total math standard score, as well as the Stanford reading score. While these findings were supported to a limited extent for reading, the findings for addition and subtraction were not supported. Similar significant results were obtained for Group 1 and Group 2 after Interventions A and B for addition and subtraction, with no significant difference between the groups at any of the assessments. There was no clear evidence in this study that the addition and subtraction scores were higher after the computer-based intervention and changes in these scores did not seem to be related to changes in the Visual Perception and VMI scores.

When controlling for performance on the VMI and each supplemental test, a significant relationship between the visual perception subtest score and maths/arithmetic achievement has been reported (Sortor and Kulp, 2003), but this was not supported in this study. Again, challenges related to mathematics, such as the ability to correctly align columns for calculations and sequencing of numbers, were not directly assessed and may provide better evidence of changes due to improvement in visual perception (Schneck, 2010b).

There is very little published information on the effect of improving visual perceptual skills using computer-based interventions on scholastic achievement other than for handwriting (Poon et al., 2010). The changes found in this study indicate that with the exception of reading scores, the results of improved visual perception in a 10-week intervention appear to have no direct carry over to the classroom academic skills. The significant changes could have been influenced by a number of variables including daily classroom input into reading and mathematics skills where inattention may still be an issue. In addition, the computer intervention did not address these skills directly but improved the underlying skills shown to be associated with these scholastic achievements.

6.3.8 Evaluation of the computer-based intervention

6.3.8.1 Evaluation of participants behaviour

The third objective evaluated the behaviour and involvement of the participants when receiving the computer-based visual perceptual intervention.

The computer programme used was based on criteria developed in Phase 2 of the study to present the "just right challenge" for meaningful participation, control over the activity, focus on task, challenge and mastery (Law, 2002). By providing this, the component of motivation described in the Dynamic Systems Model of Visual Perception was facilitated. This was further enabled by the immediate task satisfaction, as well as feedback increasing both the completion of therapeutic goals and goals attention and long-term memory (Shizgal and Hyman, 2013).

The occupational therapist research assistants reported that the participants were motivated to participate in the visual perceptual computer-based intervention and that the feedback provided by the programme was sufficient and allowed for sustained interest throughout the therapy session.

Teachers reported to research assistants that participants appeared more motivated and interactive in class after intervention and they contributed more to class discussions during the Intervention A period. Chu and Reynolds (2007) found that motivation is a key aspect of goal attainment in children diagnosed with ADHD.

Cordier et al. (2009) agreed, and said that capturing motivation is an important principle of play-based intervention for learners diagnosed with ADHD. Coté (2015) included motivation as an essential component to the DSTMVP due to the impact it has on concentration and goal attainment. The reported carry over effect to occupational performance in the classroom can be included in future research. Teachers observed that the self-esteem of participants improved, which could be due to the positive reinforcement that was embedded in the programme allowing the participants to be successful when completing the visual perceptual computer-based intervention. Teachers also reported that participants were more motivated to try difficult assignments compared to their attitude prior to intervention.

Parents reported to research assistants that participants were more motivated to go to school and to do homework during the Intervention A period. Motivation and emotion are linked in the dynamic systems theory (Coté, 2015). These aspects are important for goal attainment and attention (Coté, 2015). Increased motivational levels could have a dynamic impact on the occurrence of positive emotions and increased attention, therefore lead to successful participation. Gottfried et al. (1994) found that learners who are encouraged often have better intrinsic motivation and perform better in academic tasks. Reported positive behavioural outcomes and increased activity participation will lead to improved occupational performance.

6.3.9 Evaluation of the hardware and software used

6.3.9.1 Hardware

An advantage of the Sony VAIO-W211AX/P laptop was that it had a 10 inch screen that was convenient to use, and easy to transport and store. Safe storage of electronic devices is a priority, and the size of the laptop made it easy for the research assistants to lock in a drawer or safe place. The portability and lightweight properties of the device also assisted research assistants to easily move it to an alternative quiet room in case the regular therapy room was unavailable. Another advantage was that the device had a good battery life of 10 hours meaning the intervention would not be disrupted in the event of a power cut. This contributed to the sustainability of the intervention phase and enabling research assistants to complete 20 intervention sessions in 10 weeks. The USB capabilities assisted the researcher to load the computer-based programme on the laptop. The adjustable illumination settings of the screen assisted in modulating visual processing. A benefit of a laptop device in comparison to a tablet is that it regulates the distance from the eyes and the required neck flexion.

The switch between different activities was time consuming and the same challenges were experienced. Part of the challenge might be the slow processing speed of the Intel Atom processor. Higher-level devices might provide better performance. The speed was a challenge but not a limitation to the study due to the supervision and guidance of research assistants.

6.3.9.2 Software

The content and theme of the programme was appropriate for the participants. Activities provided an adequate challenge and the levels within each activity assisted with motivation. However, the subthemes were too detailed and participants could not relate to the various kinds of sea animals due to lack of exposure. Subthemes that are more relevant would have had a greater impact on participation, goal attainment and progress. The introduction at the beginning of the programme took too long and participants became impatient. Research assistants were however able to contain participants when they experienced frustration. Long introductions might cause frustration and participants to lose interest.

6.3.10 Conclusion

Phase 3 provided strong evidence that the additional computer-based intervention was successful as illustrated in the within group results for Group 1 and 2 for Beery VMI, motor coordination, the visual perception, all TVPS-3 index scores (overall, basic processes, sequencing and complex processes) and scholastic assessment (reading, addition and subtraction). Between group results indicated that Significant differences were obtained between Groups 1 and 2 for the scores on the Beery VMI test for VMI and the visual perception during Assessment 2, indicating the effectiveness of intervention A (additional computer-based intervention) for Group 1. Reading was the only scholastic assessment that yielded significant results in Assessment 2 for Group 1 compared to Group 2 after the additional computer-based intervention.

CHAPTER 7: CONCLUSION AND RECOMMENDATIONS

"No matter how much you want to force yourself to pay attention, boredom allows curiosity to find the key and open the dungeon door, allowing attention to escape and find some interesting place to visit"

~Edward M. Hallowell

7.1 SUMMARY

7.1.1 Phase 1

Phase 1 illustrated that learners diagnosed with ADHD have special educational needs due to their barriers of learning. Their performance at school is less effective than a normative sample (peers) in visual perceptual tasks due to poor visual attention and impulsivity. It was also highlighted that ocular-motor function should be assessed and intervention should be provided for visual perceptual dysfunction in learners diagnosed with ADHD. The most prevalent visual perceptual problems in learners diagnosed with ADHD that was included in the record review were visual discrimination, visual closure, visual spatial relations and visual sequential memory. This impacts on their academic outcomes such as reading and maths and results in lower academic results than their typical peers (Loe and Feldman, 2007).

7.1.2 Phase 2

Phase 2 emphasised the importance of the integration of clinical reasoning and literature to provide sound evidence that can support evidence-based practice. Grading and treatment principles are essential for ensuring the fidelity of the intervention. Fraser and Galinsky emphasise that defining "explicit practice principles, goals and activities" (Fraser and Galinsky, 2010):259) as well as the need for intervention are essential components in intervention research. Phase 2 also demonstrated that there are various multimedia treatment options available. However not all multimedia treatment options are equal and it is therefore important to follow scientific guidelines in the selection of the most suitable computer programme for the remediation of visual perceptual skills in 7-9 year old learners diagnosed with ADHD. A limited number of computer programmes could be reviewed due to various limitations discussed in Chapter 4. The NGT assisted in developing and intervention criteria that supported the selection of the most appropriate computer programme for the remediation of visual perceptual skills. Each intervention criterion had an allocated weighting and that assisted with determining the best suitable programme. The computer software evaluation form enabled the researcher and expert in the field to make an objective decision as to what programme would be best suited.

7.1.3 Phase 3

Phase 3 provided evidence of the effectiveness of computer-based visual perceptual training in collaboration with occupational therapy for the remediation of visual perceptual skills in 7-9 year old learners diagnosed with ADHD. This phase also provided evidence that a change in visual perception can address functional outcomes such as reading. Results of this phase contribute to evidence-based practice (EPB) for occupational therapy clinicians. Evidence-based practice is important in occupational therapy because it guides clinical decision making and ensures high quality services contributing to improved consistency and effectiveness of intervention (Bennett and Bennett, 2000). The computer provided structure for the participants diagnosed with ADHD. The boundaries and layout of the programme provided structure to reduce distractibility and increased attention to task. There is a possibility that providing visual based intervention on a vertical surface rather than horizontal might be more effective for the remediation of visual perceptual skills. A recent study revealed that head position has an impact on visual perceptual skills and attention modulation (Nakashima and Shioiri, 2015). Researchers found that head direction modulates attention for visual perception (Nakashima and Shioiri, 2015). They said people attend better to visual stimulus that is straight ahead of them due to central fixation bias (Nakashima and Shioiri, 2015). Their findings therefore confirm that a vertical surface of a computer screen is more preferable than a desk top worksheet. Phase 3 provided strong evidence that the additional computer-based intervention as successful as illustrated in the within group results for Group 1 and 2 for Beery VMI, motor coordination, the visual perception, all TVPS-3 index scores (overall, basic processes, sequencing and complex processes) and scholastic assessment (reading, addition and subtraction). Between group results indicated that Groups 1 and 2 obtained significant differences were obtained between Groups 1 and 2 for the scores on the Beery VMI test for VMI and the visual perception during Assessment 2, indicating the effectiveness of intervention A (additional computer-based intervention) for Group 1. Reading was the only scholastic assessment that yielded significant results in Assessment 2 for Group 1 compared to Group 2 after the additional computer-based intervention.

7.2 STRENGTHS OF THE STUDY

A strong point of this study is that it was done in a systematic manner and it is easy to replicate by future researchers. Replicability of a study contributes to researcher confidence and the external validity of the study (Frey et al., 2009). Replicability of the study will therefore contribute to the intervention fidelity (Parham et al., 2011). This study can be replicated in diverse population and disability groups and contributes to the evidence-based knowledge of occupational therapy therefore assisting clinicians in making informed clinical decision regarding intervention. Furthermore the study also aligns with the research priorities of WFOT of technology and occupation (World Federation of Occupational Therapists et al., 2017). There is also currently no research available on the remediation of visual perceptual in foundation phase learners using multi-media technology. Therefore this study contributes to the global interest of occupational therapy knowledge.

The strengths of the study lie in the rigour of study selection of methodological aspects, as well as the results of the study, providing a unique contribution to occupational therapy literature.

The study confirmed the need to thoroughly investigate and establish fidelity criteria in terms of treatment and grading principles when planning and selecting the virtual computer-based intervention to be used. By establishing the validity of the computer programme, it could be assumed that effective therapy for the visual perceptual deficits identified in the learners with ADHD would be offered.

The crossover research design allowed a sequence of interventions during various periods, along with the blinding of the assessor as to which group the learner was in (Piantadosi, 2005). This also allowed for all participants to receive the intervention and benefit from participation in the study.

The research design also allowed analysis of within group effects and between group results; this contributed to the verification of results and the controlling the variability of results. The intervention was effective in that all participants improved in terms of the visual perceptual skills. Variability was controlled where the measured effect of intervention was the difference in individual participants (Griel et al., 2008).

Bias was controlled by the implementation of various measures. In Phase 2 the NGT was a structured process to develop the intervention criteria that assisted in limiting the possibility of bias. The quantitative weighting of intervention criteria also limited bias in the selection of the most appropriate computer programme. During Phase 3 bias was limited by blinding the research assistants who conducted the intervention, they did not see the results of assessment. The therapist conducting the assessments did not know the names of the children because a code was assigned to each participant.

7.3 LIMITATIONS OF THE STUDY

There were however, challenges and possible perceived limitations identified. There is limited research available on the scholastic assessment, and the assessment used may not have been the correct one to verify the results. The population group, although representative of a LSEN school, was not representative of South Africa therefore limiting generalisation of the study.

The selection of computers for the intervention could have a limitation due to operational challenges, such as dragging the mouse, selecting by clicking, as these skills require refined fine motor skills in comparison to touch screen tablets. Nevertheless, the selection of computers was appropriate for the development and refinement of fine motor skills for 7 to 9 year old learners, as the benefits of using the laptop device outweighed the challenges.

Although a South African developed programme was selected that presented auditory instructions in the languages of instruction at the school, English and Afrikaans, some of the learners had a different home language and the programme was presented in their second language. A limitation to any software instruction is that the instructions are only presented in one way therefore human assistance is needed to provide clarity especially in learners with barriers to learning. It was essential for participants to understand the instructions therefore further (human) assistance was provided; the research assistants were vital for the rephrasing of the instructions and demonstrating activities when required.

Noted limitations of this study include that only three participants had previous experience with using multimedia devices for the remediation of visual perceptual skills. This impacted on the body of knowledge in the nominal group and might have affected the results of the intervention criteria. Another limitation was the number of computer programmes that was reviewed. This limitation was due to limited computer programmes available in the South African market and a lack of resources.

7.4 RECOMMENDATIONS

7.4.1 Recommendations related to new software development

These recommendations are based on the programme that was used in the study. It would be beneficial if background images are limited to simple, more mono colour images when animations are presented on the screen. It is important that the themes or icons with the games are more familiar to learners. The main theme of sea world was relevant however the range of different fish for the activities was too complicated and participants could not always relate to that. Piaget recommends development of cognition advanced from simple to complex, from concrete to abstract and from personal to worldly (Law et al., 2005). Therefore child learns concepts first in relation to self and then transfer them to words or symbols (Pulaski, 1971). The symbols/icons used in the programme can also improve to simpler images with bolder outlines. Themes related to the child and his/her direct environment might have been more successful.

It would be an advantage if the speed of instructions and animations could be automatically updated to the processing speed of the learner. A study published in

2014 indicated that learners diagnosed with ADHD and a co-morbid sensory processing disorder perform weaker in visual perception that their ADHD peers (Jung et al., 2014). Adaptation of speed will therefore facilitate better sensory processing and enhance learning.

Another suggestion is that the screen size can be adapted according to the needs of the learners. Screen size adaptation might also assist with facilitating better concentration and learning to occur.

Results of Phase 1 indicated that children diagnosed with ADHD have a need for visual tracking intervention in conjunction with visual perceptual training. It therefore suggested incorporating visual tracking with exercises with visual perceptual skills development software. It would also be advantageous if long term memory skills training can be included in the programme.

It was evident in Phase 3 that learners performed better when motivated and being encourage. The current programme did provide the motivational element and encouragement however concrete reward is lacking. Kotaman (2018) pointed out that reward plays a significant role in task persistence. An additional motivational incentive that could be added to the current software could be a printable certificate upon completion of each level.

7.4.2 Recommendations for users of multimedia devices

The parental questionnaire illustrated that children engage in electronic media on a daily basis. Caution should be taken to ensure that is a balance between concrete activities and electronic media. Increased screen time can also result in negative health outcome as screen time promotes sedentary behaviour (De Decker et al., 2012). A recent study also suggest that the use of smartphones at night might have a negative impact on sleep (Christensen et al., 2016). Parents are therefore responsible to manage the screen time behaviour of children. Kardaras (2016) wrote in his book (glow kids: how screen addiction is hijacking our kids- and how to break the trance) that screen time is becoming more prevalent each year and kids engage more in screens than previously. He said that screen time can become and addiction and that intervention is required if that is the case (Kardaras, 2016) Electronic media is therefore a wonderful tool but it also poses some threats that should be considered. When children are engaged in electronic media it is recommended that the content is educational and meaningful. Living in a rapidly evolving technological era it is very important to expose children to technology; however procedures should be in place when engaging in electronic media. Recommendations for future research include developing a protocol for the recommended use of electronic media. This protocol can contain appropriate content for various age bands and intensity of usage per age band. Parents can include screen time in their daily routine and thereby limit and monitor usage.

7.5 IMPLICATIONS OF THE STUDY

Occupational therapists working for the Gauteng Department of Education that are part of the district based support teams can use the intervention criteria to assist them in finding appropriate programmes that can remediate visual perceptual skills. Implementation of relevant educational programmes will facilitate the SIAS process (Department of Basic Education, 2014) and support the inclusion policy (Department of Basic Education, 2001) of the ministry. The evidence on the effectiveness of the programme can also serve as motivation for the procurement of educational software from the education department. Computer-based intervention will also aid the work of therapists working in the government sector with high caseloads. It will not only accelerate progress but also diversify treatment options, motivate learners and promote a pleasant learning experience. Fernández-López et al. (2013) highlights the advantages of mobile learning technology for learners with special educational needs. They observed positive effects on development and learning while using the mobile platform as well as increased interest in learning and attention. Recommendations would be made for developing the current of similar software into a smart phone application format. Tablet and smartphone application makes stimulation and early childhood intervention more accessible (Neuman, 2018).

Other school based or private occupational therapist can also use the intervention criteria in order to determine appropriate electronic media that can be prescribed for home use in addition to therapy.

It is important to involve technology due in the therapy process due to a changing world and the rapidly emerging technology, therefore empowering learners for the future. Evidence of this study suggested that technology is a tool that is motivating, engages learners and accelerate the learning process.

7.6 FUTURE RESEARCH

- Future research can be directed towards testing the use of using multimedia as a tool for the remediation of visual perceptual skills in various settings (mainstream private schools, mainstream government full service schools, other LSEN schools) to validate and generalise the results.
- Testing the use of multimedia as a tool for remediation of visual perceptual skills in other countries and across other cultures to generalise results is recommended for future research.
- Testing the use of various multimedia tools and evaluating the effectiveness of different tools in the remediation of visual perceptual skills, would be beneficial in determining the most effective one.
- Future research can be directed to testing the use of multimedia on different disabilities to remediate visual perceptual skills
- Development of a computer-based visual perceptual programme that contains only black and white images to cater for learners that have known colour-blindness.
- Translating a paper based visual perceptual assessment such as the TVPS-3 to a computer-based assessment and also determining the difference in the results of the paper and computer-based tests. Computer-based visual perceptual assessments can contribute occupational therapy if they are more accurate and objective in scoring as well as saving time and recording the progress.
- A recent research study revealed that learners diagnosed with ADHD and a co-morbid sensory processing disorder presents with weaker visual perceptual skills than ADHD peers (Jung et al., 2014). Future research can be directed into an investigation of a controlled sensory environment such as electronic media can enhance visual perceptual skills in this population group.
- Input devices can be modified to enhance or compensate for fine motor skills

- Future research can be directed to exploring the efficacy of virtual reality for the remediation of visual perceptual skills and the carry over in classroom occupations.
- Future research can consider the impact of neuro-biofeedback not only on concentration but also visual perceptual skills in learners diagnosed with ADHD.

7.7 FINAL CONCLUSION

We are currently moving towards the fourth industrial revolution; therefore we need to prepare our learners for the future (Schwab, 2017). Recommendations arising from this research such as remediating visual perception through virtual reality are an example of the fourth industrial revolution. This study illustrates that the combination of technological approaches and guidance from occupational therapists can improve access to support for learners with barriers to learning. Strong evidence of this study suggests the use of technology and multi-media use in planning and execution of visual perceptual treatment approaches. Emerging digital and electronic technology is more accessible than in the past and user-friendly. This media is interesting and appealing to children, they are therefore more motivated and perform better. Feedback provided by technology is immediate, multisensory and therefore reinforces rapid learning. This study illustrated that technology is an ideal intervention tool for children diagnosed with ADHD.

Technology is an evolving and meaningful tool that can be used to promote learning and development. It should be used with judgement and careful selection. Caution should be applied to the intensity and frequency of usage and it should be closely monitored. Computer programmes that are used for the remediation of visual perceptual skills should be used in collaboration with other approaches such as occupational therapy.

"The **computer** is incredibly fast, accurate, and stupid. Man is incredibly slow, inaccurate, and brilliant. The marriage of the two is a force beyond calculation."

~Albert Einstein~

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Appendix A: Record sheet of data collection

DEMOGRAPHIC QUESTIONNAIRE AND DATA CAPTURE TOOL AND SHEET

TVPS-R										
Code of record	**Medication**	**Grade**	**Gender**	**VD**	**VM**	**VSR**	**VFC**	**VSM**	**VFG**	**VC**
1.1	Concerta 18mg, Epilim 300mg	1	M	10	12	9	10	11	8	13

Explanation of codes:

Code of record: The first number is the grade of record and second number is the number of the record.

TVPS-R:Test of visual perceptual skills revised

VD:Visual discrimination

VSR: Visual spatial relations

VFC: Visual form constancy

VSM: Visual sequential memory

VFG: Visual figure ground

VC: Visual closure

Appendix B: Ethics permission from the HREC of the University of the Witwatersrand

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

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Ms Fransli Buckle

CLEARANCE CERTIFICATE	**M120901**
PROJECT	A Computer-Based Visual Perception Programme for Grade 2 Learners Diagnosed with Attention Deficit Hyperactivity Disorder
INVESTIGATORS	Ms Fransli Buckle.
DEPARTMENT	Department of Occupational Therapy
DATE CONSIDERED	28/09/2012
DECISION OF THE COMMITTEE*	Phase 1 Approved

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

DATE 22/10/2012 **CHAIRPERSON** ....
(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable
cc: Supervisor : Dr Denise Franzsen

DECLARATION OF INVESTIGATOR(S)

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

R14/49 Ms Fransil Buckle

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M150615

NAME: **(Principal Investigator)**	Ms Fransil Buckle
DEPARTMENT:	Occupational Therapist Gauteng Department of Education School of Achievement
PROJECT TITLE:	A Computer-Based Visual Perception Programme for 7-9 Year Old Leaners Diagnosed with Attention Deficit Hyperactivity Disorder
DATE CONSIDERED:	26/06/2015
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Mrs Denise Franzsen and Prof Joanne Poterton
APPROVED BY:	Professor P Cleaton-Jones, Chairperson, HREC (Medical)
DATE OF APPROVAL:	20/07/2015

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

Appendix C: Information sheet for parents

Evaluation of a computer-based intervention for visual perceptual dysfunction in 7-9 year old learners diagnosed with Attention Deficit Hyperactivity Disorder

Dear Parents

I am an occupational therapist currently registered for my PHD at the University of the Witwatersrand. I am investigating the effectiveness of a computer-based visual perception programme for 7-9 year old learners diagnosed with Attention Deficit Hyperactivity Disorder.

This research will give us insight in the amount of learning that takes place when a learner received constant multi-sensory feedback from a computer programme. It will also provide evidence of the effectiveness of a therapeutic selected commercial computer programme that can be accessed and administered by the child in the home or school environment.

The first part of the research project is a retrospective record review of learner profiles and occupational therapy reports. The purpose of the first phase is to identify the most prevalent visual perceptual problems learners with ADHD encounters. Intervention can then be planned accordingly. Records of 2010-2012 will be used.

Results are confidential and no names will be used in the data collection. All identifying data will be kept separate by the occupational therapist in a secure location. All records will be stored on completion of the research for six years according to HPCSA specifications.

I would like to request your permission to use your childs learner profile and occupational therapy report. Participation in this research project is voluntary. You can request withdraw at any stage, should you wish without any consequence. Feedback from the study is available on request. There will be no benefit to participants.

Please complete the consent form for this research below.

If you have any further questions please do not hesitate to contact me on 083 978 4816. If there are any queries about ethical considerations or complaints please contact the chairman of the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, Prof P Cleaton-Jones on 011 7171234.

Kind regards

Fransli Buckle

INFORMED CONSENT PHASE 1

______________________________ agree that my child can take part in the study for the research entitled:- "Evaluation of a computer-based visual perception programme for 7-9 year old learners diagnosed with Attention Deficit Hyperactivity Disorder. We would need to go through school files and occupational therapy reports of 7-9 year old learner to see in what areas we can help. Do you agree to give us permission to use your child`s school file and occupational therapy report from 2010-2012

Name of Child ________________________Signed ________________________

Date ___________________________

INFORMED CONSENT PHASE 3

______________________________ agree that my child can take part in the study for the research entitled:- "Evaluation of a computer-based visual perception programme for 7-9 year old learners diagnosed with Attention Deficit Hyperactivity Disorder. I agree that my child can receive intervention as per requirement receiving routine therapy and additional computer-based intervention.

Name of Child ________________________Signed ________________________

Date ___________________________

SIGNED ASSENT PHASE 1

Dear Learner

We are doing a project to see if computer games can help learners learn better. ? We would need to go through school files and occupational therapy reports of 7-9 year old learner to see in what areas we can help. Do you agree to give us permission to use your school file and occupational therapy report from 2010-2012. If you feel at any stage that you do not want to participate anymore, you can just tell me or your teacher..

Signed ________________________ Date ___________________________

Witnessed___________________________

LEARNER ASSENT PHASE 3

We are doing a project to see if computer games can help learners learn better. ? We need you to work on a computer programme 30 minutes each day for one school term. You will be required look at pictures and tell us what you see. This new computer programme might teach you skills that could help you with reading and writing. If you feel at any stage that you do not want to participate anymore, you can just tell me. Do you agree not to play any new electronic games at home or school for the duration of this school term If you feel at any stage that you do not want to participate anymore, you can just tell me or your teacher..

Signed ________________________ Date ___________________________

Witnessed___________________________

Appendix D: Permission to conduct record review principal School of Achievement.

PRESTASIESKOOL

SCHOOL OF ACHIEVEMENT

TAX EXEMPTION NUMBER : 930021659

2012/09/26

TO WHOM IT MAY CONCERN:

On behalf of School of Achievement we are granting Ms. Fransli Buckle permission to conduct research entitled: "A computer-based visual perception intervention program for Gr 2 learners diagnosed with Attention Deficit Hyperactivity Disorder" at our school

She will be allowed access to school files of the foundation phase learners and the occupational therapy assessment information from 2010-2012. She would be allowed to use the computer room at the school for 20 minutes a day during two school terms.

Sincerely,

TINUS DU PREEZ

PRINCIPAL

BELIEVING IS ACHIEVING GLO EN PRESTEER

Principal • Tinus du Preez • Hoof
Private Bag 3 • Privaatsak 3 • Elspark • 1418 • Tel: (011) 916 1917/8/9/20 • Fax: (011) 916 3891
Email: info@schoolofachievement.co.za • Web Page: www.schoolofachievement.co.za

Appendix E: Gauteng Department of Education Research Approval Letter

GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

For administrative use:
Reference no: D2013/319

GDE RESEARCH APPROVAL LETTER

Date:	**1 March 2013**
Validity of Research Approval:	**1 March 2013 to 20 September 2013**
Name of Researcher:	**Buckle F.**
Address of Researcher:	**P.O. Box 15664**
	Riverfield
	1564
Telephone Number:	**011 392 5948; 083 978 4816**
Email address:	**franslis@gmail.com**
Research Topic:	**A computer-based visual perception programme for 8-9 year old learners diagnosed with Attention Hyperactivity Disorder**
Number and type of schools:	**ONE LSEN School**
District/s/HO	**Ekurhuleni South**

Re: Approval in Respect of Request to Conduct Research

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

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

2013/03/04

1

Making education a societal priority

Office of the Director: Knowledge Management and Research
9th Floor, 111 Commissioner Street, Johannesburg, 2001
P.O. Box 7710, Johannesburg, 2000 Tel: (011) 355 0506
Email: David.Makhado@gauteng.gov.za
Website: www.education.gpg.gov.za

1. *The District/Head Office Senior Manager/s concerned must be presented with a copy of this letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.*
2. *The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.*
3. *A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.*
4. *A letter / document that outlines the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.*
5. *The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.*
6. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
7. *Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year. If incomplete, an amended Research Approval letter may be requested to conduct research in the following year.*
8. *Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.*
9. *It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.*
10. *The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.*
11. *The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.*
12. *On completion of the study the researcher/s must supply the Director: Knowledge Management & Research with one Hard Cover bound and an electronic copy of the research.*
13. *The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.*
14. *Should the researcher have been involved with research at a school and/or a district/head office level, the Director concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.*

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

Makhado
....

Dr David Makhado
Director: Education Research and Knowledge Management

DATE: 2013/03/04 ....

Office of the Director: Knowledge Management and Research
9th Floor, 111 Commissioner Street, Johannesburg, 2001
P.O. Box 7710, Johannesburg, 2000 Tel: (011) 355 0506
Email: David.Makhado@gauteng.gov.za
Website: www.education.gpg.gov.za

GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

For administrative use:
Reference no. D2015 / 452 A

GDE AMMENDED RESEARCH APPROVAL LETTER

Date:	24 March 2015
Validity of Research Approval:	13 April 2015 to 2 October 2015
Previous GDE Research Approval letter reference number:	D 2013/319 dated 1 March 2013
Name of Researcher:	Buckle F.
Address of Researcher:	P.O. Box 15664
	Riverfield
	1564
Telephone Number:	083 978 4816
Email address:	franslis@gmail.com
Research Topic:	A computer-based visual perception programme for 7-9 year old learners diagnosed with ADHD
Number and type of Schools:	ONE LSEN School
District/HO:	Ekurhuleni South

RE: Approval in Respect of Request to Conduct Research

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

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

CONDITIONS FOR CONDUCTING RESEARCH IN GDE

Making education a societal priority

Office of the Director: Knowledge Management and Research
9th Floor, 111 Commissioner Street, Johannesburg 2001
P.O. Box 7710, Johannesburg, 2000 Tel: (011) 355 0560
Email:David.Makhado@gauteng.gov.za
Website: www.education.gpg.gov.za

1. The District/Head Office Senior Manager/s concerned must be presented with a copy of this letter;
2. A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB);
3. A letter / document that outlines the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned;
4. The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, SGBs, teachers and learners involved. Participation is voluntary and additional remuneration will not be paid;
5. Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal and/or Director must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage;
6. Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year. If incomplete, an amended Research Approval letter may be requested to conduct research in the following year;
7. Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.
8. It is the researcher's responsibility to obtain written parental consent and learner;
9. The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources;
10. The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations;
11. On completion of the study the researcher must supply the Director: Education Research and Knowledge Management with one Hard Cover, an electronic copy and a Research Summary of the completed Research Report;
12. The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned; and
13. Should the researcher have been involved with research at a school and/or a district/head office level, the Director and school concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

....

Mrs F.L. Tshabalala

Acting Director: Education Research and Knowledge Management

DATE: 02/04/2015

2

Making education a societal priority

Office of the Director: Knowledge Management and Research
9th Floor, 111 Commissioner Street, Johannesburg, 2001
P.O. Box 7710, Johannesburg, 2000 Tel: (011) 355 0506
Email: David.Makhado@gauteng.gov.za
Website: www.education.gpg.gov.za

For administrative use:
Reference no. D2016 / 307A
Enquiries: Diane Buntting: 011 843 6503

GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

GDE AMMENDED RESEARH APPROVAL LETTER

Date:	5 October 2015
Validity of Research Approval:	8 February 2016 to 30 September 2016
Previous GDE Research Approval letter reference number:	D 2013/319 dated 1 March 2013 D2015 / 452 A dated 24 March 2015
Name of Researcher:	Buckle F.
Address of Researcher:	P.O. Box 15664
	Riverfield
	1564
Telephone Number:	083 978 4816
Email address:	franslis@gmail.com
Research Topic:	A computer-based visual perception programme for 7-9 year old learners diagnosed with ADHD
Number and type of Schools:	ONE LSEN School
District/HO:	Ekurhuleni South

RE: Approval in Respect of Request to Conduct Research

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

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

CONDITIONS FOR CONDUCTING RESEARCH IN GDE

2015/10/06

Making education a societal priority

Office of the Director: Knowledge Management and Research
9th Floor, 111 Commissioner Street, Johannesburg 2001
P.O. Box 7710, Johannesburg, 2000 Tel: (011) 355 0560
Email:David.Makhado@gauteng.gov.za
Website: www.education.gpg.gov.za

Appendix F: Nominal Group Invitation

School-Based Occupational Therapy Group

ATT: Jaclyn Craig
E-mail: jcraigot@gmail.com
Fax number: 0867296433

e-mail: sbot_group@yahoo.com

21 August 2015

Dear Therapist

It is that time again! We are planning a workshop for the School-Based OT's in Gauteng on Saturday 19th September 2015. We are looking for occupational therapists working at LSEN schools in Gauteng with foundation phase learners that have more than 10 years' experience. This workshop will form part of a research project entitled "A computer based visual perception programme for 7-9 year old learners diagnosed with attention deficit hyperactivity disorder". Ethical clearance has been granted by the HRCE committee of the University of Witwatersrand (M150615). The guest speaker will be Fransli Buckle. Attendance certificates will be issued. The limit of the workshop is 9 delegates and delegates will be selected based on experience. Please indicate your experience when applying Registration will be at 08:00 and the meeting will start at 08:30 and continue until 13H00. Refreshments will be served. There will also be exhibitors. There will be no cost for this workshop.

Come and join us for an informative morning. Please reply by Monday 14th September 2015. Please fax your reply slip to 0867296433 for attention: Jaclyn Craig or e-mail it to jcraigot@gmail.com.

We are looking forward to seeing you there!

Kind Regards
Jaclyn Craig

Fransli Buckle • Erika Jooste • Willemine van Velden • Wilna van Niekerk • Jaclyn Craig •
Publications Secretary Treasurer CPD and Vice Chairperson Chairperson

Appendix G : Information sheet occupational therapists to participate in a workshop and nominal group technique

Evaluation of a computer-based intervention for visual perceptual dysfunction in 7-9 year old learners diagnosed with Attention Deficit Hyperactivity Disorder

Dear Colleague,

This letter is to follow-up on the discussion that we had earlier today. I am currently registered for a PHD degree at the University of the Witwatersrand. I would like to establish the intervention criteria for the use of computer-based computer programme to treat visual perception for 7-9 year old learners diagnosed with Attention Deficit Hyperactivity Disorder and evaluate the effectiveness of the programme.

You have been selected to be one of the experts to establish the content of the programme. You will receive more information prior to the study.

You can withdraw at any time during the study. If there are any queries about ethical considerations or complaints please contact the chairman of the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, Prof P Cleaton-Jones on 011 7171234. Permission to conduct research will be applied for by the Gauteng Department of Education and I will send you a copy.

I look forward to the opportunity to work with you. Please complete the informed consent sheet.

Yours truly,

Fransli Buckle

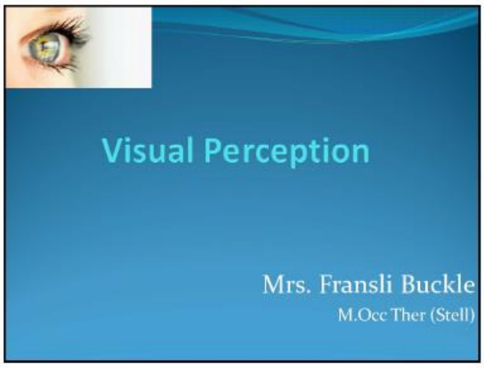
INFORMED CONSENT

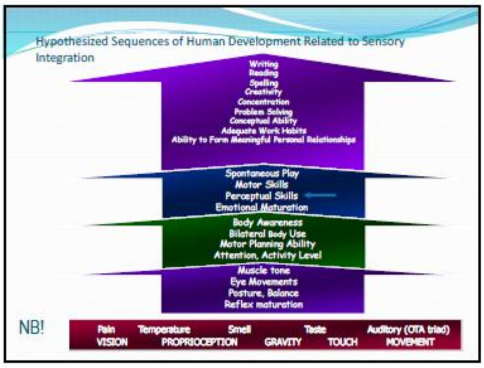
_____________________________ agree to take part in a focus group for the research entitled Evaluation of a computer-based visual perception programme for 7-9 year old learners diagnosed with Attention Deficit Hyperactivity Disorder.

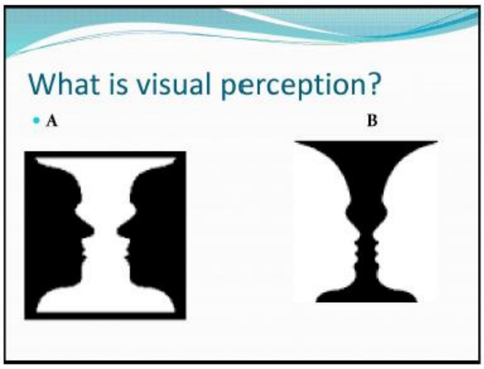
Signed ________________________

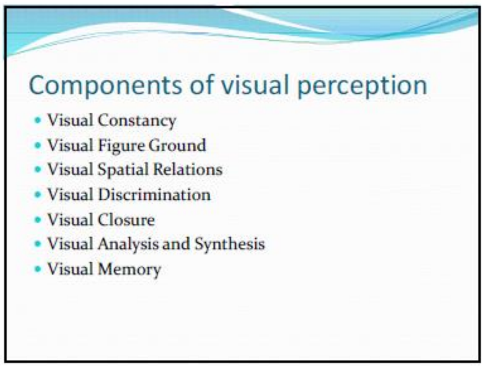
Date ___________________________

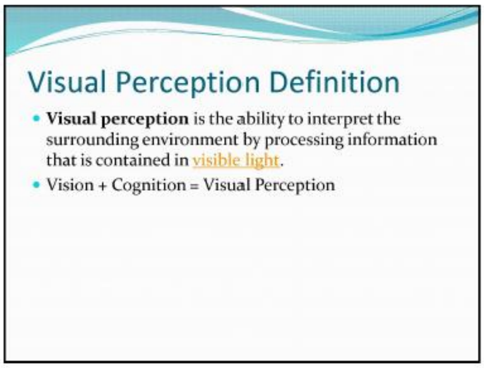
Appendix H: Nominal group power point

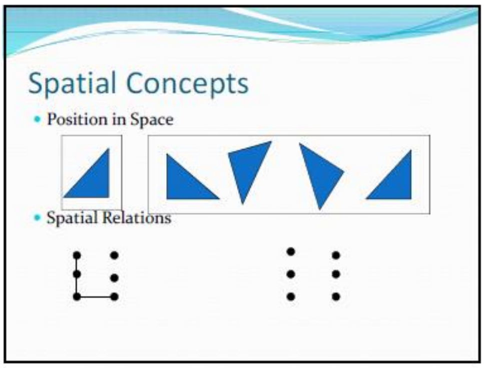






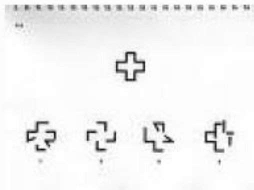




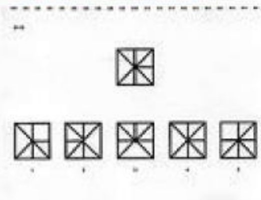


Perceptual Constancy

Visual Closure



Visual Discrimination



Visual perception

FUCTIONAL PROBLEMS IN THE CLASSROOM

- Difficulty staying on line when writing
- Quality/size varies from sustained writing output
- Reverses/ inverts letters / numbers with similar structure n/u b/d
- Difficulty with sequencing was/saw, of/for, 34/43,
- Incorrect word order calm/clam, barn/bran
- Poor inconsistent spacing of letters
- Difficulty copying from book / chalkboard

Figure Ground

Visual perception

FUCTIONAL PROBLEMS IN THE CLASSROOM

- Skips lines / confusion when moving on to the next line
- Loses place when copying
- Reads slowly/ hesitantly
- Easily distracted by visual stimuli
- Does not complete words CRAC=CRACK
- Poor task completion
- Confuses similar letters r/n, n/m
- Poor discrimination car not cat
- Do not notice small difference in letters
- Poor memory of spelling words
- Difficulty writing from dictation

Visual perception

FUCTIONAL PROBLEMS IN THE CASSROOM

- Forget what has been read or seen
- Guesses word from initial/middle/final letters
- Incorrect letter information
- Tends to omit letters

Visual perception ADHD

Table 1: Percentage of the sample that scored below the median on the TVPS-R subtests. (n=122)

Subtests of TVPS -R	Percentage
Visual Closure	50.82%
Visual Sequential Memory	54.1%
Visual Discrimination	50.82%
Visual Memory	50.00 %
Visual Spatial Relations	50.00%
Visual Figure – Ground	29.51%
Visual Form Constancy	22.95%

Visual Perception and ADHD

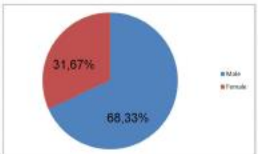
Visual perception ADHD

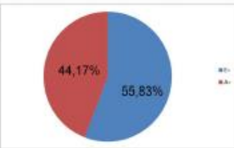
- 58% of learners had abnormal eye movements.
- Data suggested that the learners
  - frequently lost eye contact with the moving visual stimulus,
  - had convergence difficulties
  - eyes frequently jumped when crossing the midline.

  The observation of dysfunctional eye movements was consistent with literature findings. Neurophysiologists confirmed that children and adults diagnosed with ADHD has difficulties with occulo-motor tasks related to saccadic movement5. Occulo-motor exercises were therefore be incorporated in the programme and were discussed under the heading complimentary treatment.

Visual perception ADHD

- Retrospective record review OT Ax reports 2008-2012
- (7-9 year old learners)
- n=122
- TVPS-R + observations





Visual perception ADHD

- Visual closure, visual sequential memory and visual discrimination= 3 most common occurring motor free visual perceptual problems

Visual perception ADHD

- Visual memory was the fourth visual perceptual component that was considered however research done by Richmond and Holland who recommended that visual memory and visual sequential memory should be treated together because assessments of these components appear to be equally accurate in determining difficulties in short term memory.

Type of Electronic Media for Rx

- Smart Phone App
- Tablet
- PC
- Video Games

Visual perception ADHD

- Fifty percent of the sample scored below the median for visual memory with a similar score being obtained for visual spatial relations . Therefore visual spatial relations was also be included in the programme because it was observed from clinical experience that learners often still have difficulties with spatial relationships in Grade 2. This is supported by research that indicates learners diagnosed with ADHD often reverses letters when reading or writing, difficulty learning left and right, poor spatial organization.

Visual Perceptual PC games

- Cami Perceptual
- Sea world adventures
- Matha Magic

Visual Perception Rx Electronic Media

Perceptual Smart Phone Apps

Android

Visual Discrimination
- What's the Difference
- Spot the differences

Visual Memory
- Memory game
- Match up

Spatial
- Spatial orientation

Appendix I: Ideas that was not valid in the nominal group technique

Visual Memory

- All the visual memory treatment and grading principles was accepted.

Visual Discrimination

- Grading of general to specific, whole to parts and concrete to abstract was recommended to move to the general grading section and not duplicated under visual discrimination as well.

Visual Spatial Relations

- All treatment and grading principles for visual spatial relations was accepted.

Visual Closure

- All treatment and grading principles for visual closure was accepted.

General Grading principles

- All general grading principles was accepted.

General intervention principles of learning from mosey(Mosey 1995)

The following grading principal was excluded by the nominal group technique:

- Trial and error, shaping and imitation of models are important learning techniques.

Guidelines when using activity worksheets or graphic material to reduce visual distractibility:

- All guidelines were accepted.

Proposed mechanical requirements of a computer programme for the remediation of visual perceptual skills

- All requirements were accepted.

Appendix J: Therapist questionnaire of using multimedia technology as therapeutic medium.

TREATMENT OF VISUAL PERCEPTUAL DYSFUNCTION IN LEARNERS DIAGNOSED WITH ADHD USING MULTI-MEDIA TECHNOLOGY

1. Do you use computerized computer programme to treat visual perception dysfunction with learners that has been diagnosed with ADHD?

- ◯ Yes
- ◯ No

2. Which computer programme do you use to treat visual perception in learners diagnosed with ADHD?

3. Which visual perceptual constructs are treated by the computer programme you use?

- ☐ Perceptual Constancy
- ☐ Spatial Relations
- ☐ Figure Ground
- ☐ Visual Closure
- ☐ Visual Discrimination
- ☐ Visual Memory
- ☐ Visual Sequential Memory
- ☐ Motor Co-ordination
- ☐ VMI

Other (please specify)

4. How often do you use the computer programme to treat visual perceptual problems in learners diagnosed with ADHD?

- once a week
- twice a week
- three times a week
- four times a week
- five times a week
- once a month

5. What is the duration of learner's engagement with the computer programme per session? (minutes)

6. How user-friendly is the computer programme's interface of the programme that you use?

- Extremely user-friendly
- Very user-friendly
- Moderately user-friendly
- Slightly user-friendly
- Not at all user-friendly

7. Which of the following devices do you use for visual perceptual treatment of learners diagnosed with ADHD?

- Laptop
- Desktop
- Tablet
- Smartphone

9. Do you treat visual perceptual problems in groups or individually using computer programme?

- ○ Individual
- ○ Group

Other (please specify) ______

10. Do you see progress when using computer programme to treat visual perception in learners diagnosed with ADHD? How was progress measured? (Please comment)

- ☐ Yes
- ☐ No

Other (please specify) ______

Appendix K: Demographic questionnaire for parents to complete of participants in Phase 3

Participant Code:	
Date of Birth:	
Age:	
Sex:	
Diagnosis:	
Date of Diagnosis:	
Prescribed Medication:	
Alternative Medication Supplements/Vitamins:	
Class:	

QUESTIONNAIRE ON THE ELECTRONIC MEDIA HABITS OF THEIR CHILDREN

1. **What electronic media does your child use at home? (more than 1 can be selected)**
   A. Standard laptop
   B. Mini laptop
   C. Desktop computer
   D. Ipad/ Tablet
   E. Smartphone
   F. TV games (Playstation, Xbox, Sega ect)
   G. TV games with motion sensor (Wii, Xbox kinetic)

H. Handheld games (PSP, Gameboy,
I. Other________________________
J. Please comment what is the electronic media that are most frequently used by your child____

2. **How often does your child use the electronic device?**
   A. Once a week
   B. Twice a week
   C. Three days a week
   D. Four days a week
   E. Five days a week
   F. Six days a week
   G. Seven days a week

3. How many times a day does your child engage in electronic media?

   A. Once a day
   B. Twice a day
   C. Three times a day
   D. Four times a day
   E. Five or more
   F. If more than five please comment how many ______________

4. **What is the duration of your child's engagement in electronic media?**
   A. 10- 30 Minutes at a time
   B. 30 minutes to 1 hour at a time
   C. 1- 2 hours at a time
   D. 3-5 hours at a time
   E. More than 6 hours

5. **What is the purpose of engagement in electronic media?**
   A. Communication
      a. Skype
      b. Whats app
      c. Texting
      d. e-mail
      e. Other____
   B. Recreation (Games)
      a. Strategy games

b. Fighting games
c. Building/ construction games
d. Racing / Vehicle simulator
e. Name the game that are most frequently played and give a brief description of the purpose____

____

C. **Educational**

a. Letters / Spelling
b. Stories
c. Memory
d. Visual Perception
e. Maths
f. Board games
g. Other____

Appendix L: Teachers checklist to measure functional outcomes (Richmond and Holland, 2010)

Teacher Checklist — Classroom Performance

Date: ....

Name of Learner: ....

Date of Birth: ....

Age: ....

Grade: ....

School: ....

Teacher: ....

Please complete this form according to the learner's general performance, without using a fine tooth comb to find fault, but also without excusing obvious errors.

Is the learner on any medication?

Yes	No	Specify

	MOSTLY/ DAILY	OFTEN/ 1xWEEK	SELDOM	NEVER
CATEGORY A				
Incorrect pencil grip				
Presses very hard, holds pencil lightly, tremor				
Inconsistent rhythm; jerky, shaky letters				
Difficulty staying on the line				
Quality/size varies with sustained written output				
Poor desk posture/shifts around in chair				
CATEGORY B				
Reverses or inverts letters/numbers with similar structure but different orientation e.g. n/u, b/d, 2/S				
Difficulty with sequencing e.g. was/saw, of/for, 34/43 or phonic elements in incorrect order e.g. calm/clam, barn/bran				
Difficulty with place value in mathematics				
Poor/inconsistent spacing of letter or words				
Disorganised layout on page				
Difficulty with concepts of top, bottom, before, after, left, right				
Poor sequencing of events in story writing				
Confuses months, days, seasons, time of day				
Trouble observing the margin				
Difficulty seeing patterns and repeating them				
Difficulty seeing the link between ideas, pictures or events				
CATEGORY C				
Difficulty copying from book				
Difficulty copying from chalkboard				
Sees image is incorrect and keeps trying to correct it				
Difficulty with diagonal lines eg ✞, ✂, A				
CATEGORY D				
Skips lines/confusion when moving on to the next line				
Uses marker/finger to read				
Loses place on page or when copying				
Easily distracted by visual stimuli				
Reads slowly/hesitantly				
Unable to find individual detail in a picture or story				
Difficulty choosing relevant/important information (comprehension)				

	MOSTLY/ DAILY	OFTEN/ 1xWEEK	SELDOM	NEVER
CATEGORY E				
Does not complete words e.g. CRAC = CRACK, th = the				
Difficulty solving abstract problems involving analysis and synthesis skills				
Difficulty reading a word by the end of a line e.g. mis- on one line and -take on next line = mistake				
Sound out words correctly but unable to combine the letters to form the word				
Difficulty completing problems e.g. 3+ ____ = 11				
CATEGORY F				
Poor task completion/can't decide when a task is complete				
Qaulity of writing decreases with speed increase				
Writing/motor speed slow (not due to poor concentration)				
CATEGORY G				
Confuses similar letters e.g. r/n, n/m				
Does not always recognise a word just read				
CATEGORY H				
Poor discrimination e.g. car/cat				
Does not notice small differences in letters e.g. h/n				
Does not notice small difference in works or pictures eg. pin/pen				
Difficulty with sorting, matching and comparing information				
Does not pay attention to detail				
CATEGORY I				
Poor memory of learned spelling				
Difficulty writing from dictation				
Forgets what has just been read or seen				
CATEGORY J				
Guesses word from initial/middle/final letters				
Incorrect letter information: specify please				
Tends to omit letters				
Reads very slowly				

.... *continued on page 16*

Intelligence range

	Below 80	81 - 90	91 - 110	111 - 120	120 plus
Verbal					
Performance					
Total					

Scores of last three tests in the following:

SUBJECT	SCORE 1	SCORE 2	SCORE 3	AVERAGE
Mathematics	/	/	/	/
Spelling	/	/	/	/
Dictation	/	/	/	/
Comprehension	/	/	/	/
Learning subjects	/	/	/	/

Appendix M: TVPS-3 Scoresheet

TEST OF VISUAL PERCEPTUAL SKILLS
3RD EDITION

TVPS 3

Name: ______________________ Gender: ______ Grade: ______________

School: ______________________ Examiner: ______________________

Reason for Testing: ______________________________________

Date of Test ______ year ______ month ______ day

Date of Birth ______ year ______ month ______ day

Chronological Age ______ year ______ month ______ day*

Do not round months up by one if days exceed 15

Student has known (diagnosed) attention problems? ☐ Y ☐ N

Student has known (diagnosed) visual problems? ☐ Y ☐ N

Subtests	Raw Score	Scaled Score	Percentile Rank	Overall	Basic Processes	Sequencing	Complex Processes
	Subtest Scores			**Index Scores**			
1. Visual Discrimination (DIS)							
2. Visual Memory (MEM)							
3. Spatial Relations (SPA)							
4. Form Constancy (CON)							
5. Sequential Memory (SEQ)							
6. Figure Ground (FGR)							
7. Visual Closure (CLO)							
			Sum of Scaled Scores				
			Standard Scores				
			Percentile Rank				
				Overall	Basic	Sequencing	Complex

%ile Rank	Scaled Score	DIS	MEM	SPA	CON	SEQ	FGR	CLO	OVERALL	BASIC	SEQUEN.	COMPLEX	Standard Score	% ile Rank
		SUBTEST SCALED SCORES							INDEX AND OVERALL SCORES					
>99	19												145	>99
>99	18												140	>99
99	17												135	99
98	16												130	98
95	15												125	95
91	14												120	91
84	13												115	84
75	12												110	75
63	11												105	63
50	10												100	50
37	9												95	37
25	8												90	25
16	7												85	16
9	6												80	9
5	5												75	5
2	4												70	2
1	3												65	1
<1	2												60	<1
<1	1												55	<1

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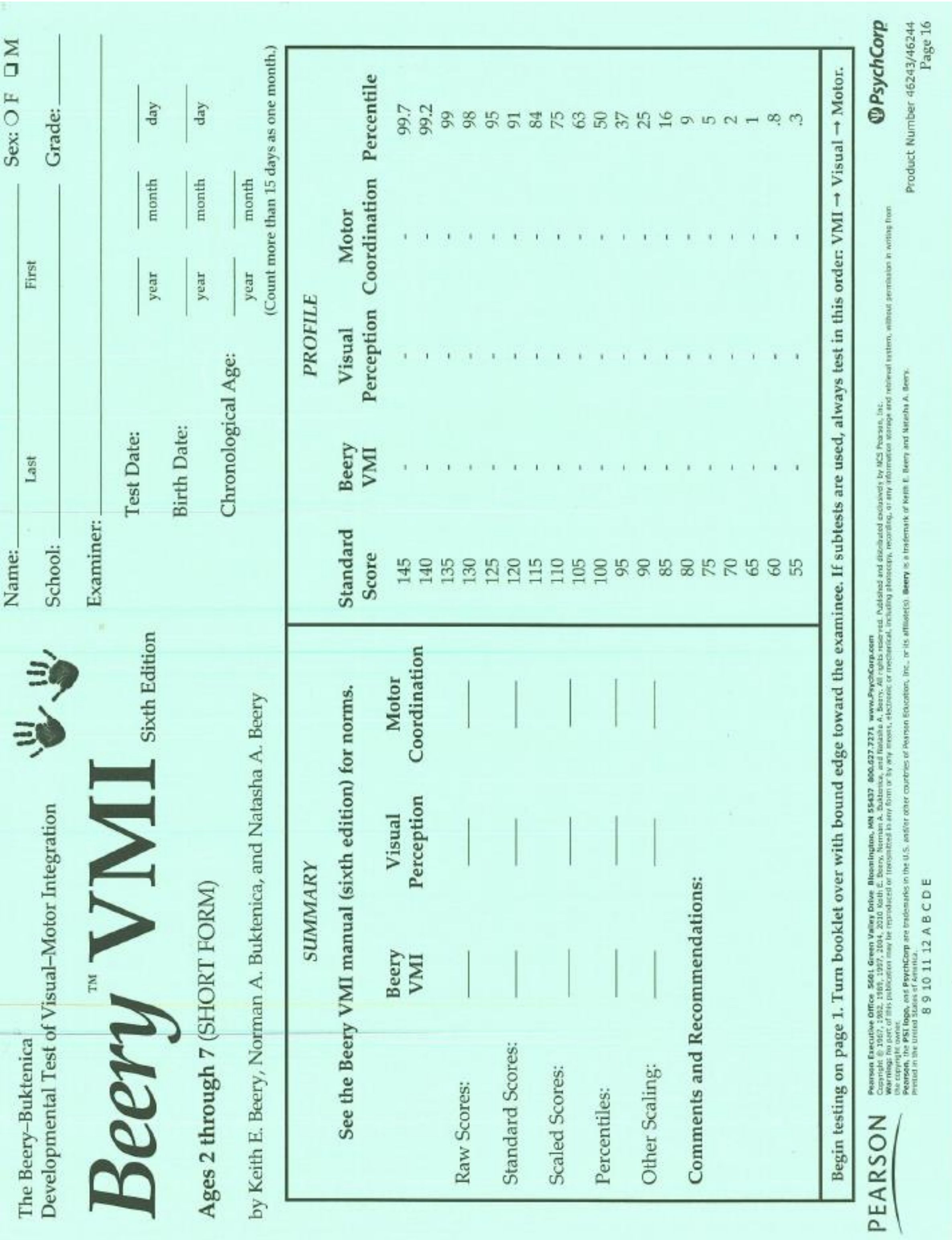
Appendix N: Beery VMI score sheet


The Beery–Buktenica
Developmental Test of Visual–Motor Integration

Beery™ VMI Sixth Edition

Ages 2 through 7 (SHORT FORM)

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

Name: ______ Last ______ First ______ Sex: ○ F ❑ M
School: ______ Grade: ______
Examiner: ______

Test Date: ____ year ____ month ____ day
Birth Date: ____ year ____ month ____ day
Chronological Age: ____ year ____ month
(Count more than 15 days as one month.)

SUMMARY

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

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

Comments and Recommendations:

PROFILE

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

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

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Page 16

Appendix O: Scholastic test score sheet

3437/1

NAME OF TESTEE ______________________

SCHOOL ______________________

ACTUAL AGE ______YEARS ______MONTHS

ONE MINUTE READING TEST

is	me	on	at	by	so	us	7
an	it	or	be	to	as	he	14
of	in	go	up	am	if	no	21
we	my	ox	do	the	and	for	28
but	him	are	can	she	dog	let	35
you	not	was	out	try	see	mix	42
cat	now	boy	saw	bit	met	top	49
run	man	pet	lot	get	dig	van	56
bad	red	cup	bee	lit	pin	had	63
ran	pen	nut	big	old	yet	rob	70
gun	leg	fun	lip	new	fog	has	77
sit	sly	wig	mud	box	ink	sat	84
end	cut	pay	fed	who	six	lad	91
met	dry	cow	his	peg	tin	say	98
eat	any	far	set	bud	kid	pup	105
fox	ask	egg	cab	ill	use	jam	112
all	pit	got	sad	tea	sky	one	119
yes	fur	act	toe	her	own	ten	126
arm	rock	gone	feel	that	rich		132
till	long	flat	this	part	foot		138
maid	upon	came	mile	back			143
sand	time	said	then	wall			148
into	were	done	walk	much			153
loss	seen	went	with	come			158

Number right ______

Test age ______

3437/2

EEN-MINUUT OPTELTOETS / ONE MINUTE ADDITION TEST

Naam van toetsling/Name of Testee : ____________________________________

Werklike ouderdom/Actual age : ____j/yr ____md/mo Skool/School : ____________________

TEL OP / ADD :

1	1 + 2	____________
2	4 + 1	____________
3	2 + 2	____________
4	2 + 4	____________
5	3 + 2	____________
6	4 + 3	____________
7	2 + 5	____________
8	5 + 4	____________
9	3 + 5	____________
10	8 + 2	____________
11	4 + 4	____________
12	5 + 2	____________
13	6 + 4	____________
14	1 + 8	____________
15	3 + 7	____________
16	6 + 3	____________
17	2 + 6	____________
18	5 + 5	____________
19	7 + 2	____________
20	4 + 6	____________
21	7 + 5	____________
22	8 + 3	____________
23	4 + 9	____________
24	6 + 8	____________
25	7 + 6	____________
26	9 + 8	____________
27	9 + 6	____________
28	8 + 7	____________
29	5 + 9	____________
30	7 + 9	____________

Aantal reg/Number right ______ Toets ourderdom/Test age ____j/yr ____md/mo

3437/2

EEN-MINUUT AFTREKTOETS / ONE MINUTE SUBTRACTION TEST

Naam van toetsling/Name of Testee : ______________________________

Werklike ouderdom/Actual age : ____j/yr ____md/mo Skool/School : ______________________

TREK AF / SUBTRACT :

1	2 – 1	________
2	3 – 2	________
3	5 – 1	________
4	6 – 2	________
5	5 – 3	________
6	2 – 2	________
7	7 – 2	________
8	6 – 4	________
9	7 – 3	________
10	6 – 3	________
11	8 – 2	________
12	7 – 5	________
13	8 – 3	________
14	7 – 4	________
15	9 – 3	________
16	8 – 5	________
17	10 – 4	________
18	9 – 5	________
19	10 – 3	________
20	9 – 4	________
21	11 – 2	________
22	10 – 6	________
23	12 – 3	________
24	11 – 6	________
25	12 – 5	________
26	13 – 4	________
27	15 – 9	________
28	14 – 6	________
29	17 – 8	________
30	16 – 7	________

Aantal reg/Number right _____ Toets ourderdom/Test age ____j/yr ____md/mo

Appendix P: Tracking grid for research assistance

Name of research assistant:		Participant code:
Date:	**Learner comment**	**Research Assistant Observation**
Session 1		
Session 2		
Session 3		
Session 4		
Session 5		
Session 6		
Session 7		
Session 8		
Session 9		
Session 10		
Session 11		
Session 12		
Session 13		
Session 14		
Session 15		
Session 16		
Session 17		
Session 18		
Session 19		
Session 20		

Appendix Q: Summary of Perceptual Skills of Sea World Adventures™

SUMMARY OF PERCEPTUAL SKILLS													
	Turtle	Angelfish	Dolphin	Shark	Sardines	Lobster	Manta Ray	Seal	Whales	Seahorse	Colour fish	Jelly Fish	Killer whale
Visual memory	☺	☺	☺		☺	☺			☺	☺			☺
Visual discrimination	☺	☺	☺	☺		☺	☺	☺	☺	☺		☺	☺
Visual observation & distinction	☺	☺	☺		☺	☺	☺	☺	☺	☺		☺	☺
Visual analysis & synthesis		☺	☺	☺		☺	☺	☺	☺	☺		☺	☺
Visual closure		☺	☺			☺		☺			☺	☺	
Foreground-background recognition			☺			☺							
Form recognition	☺	☺	☺	☺	☺	☺	☺	☺	☺	☺	☺	☺	
Form-Consistency	☺		☺							☺	☺		
Form distinction	☺	☺	☺	☺		☺	☺	☺	☺	☺	☺	☺	
Dimensional forms		☺	☺	☺	☺		☺	☺	☺	☺			
Colour recognition & distinction	☺	☺	☺	☺		☺	☺	☺	☺	☺	☺	☺	
Sizes & proportions	☺		☺	☺	☺		☺	☺	☺	☺		☺	
Mathematical concepts & relations			☺	☺			☺	☺	☺	☺	☺		☺
Auditory memory	☺				☺								☺
Association	☺	☺		☺	☺			☺	☺				☺
Concentration		☺	☺		☺	☺			☺	☺			☺
Differences & similarities	☺	☺	☺	☺	☺		☺	☺	☺	☺			☺
Succession		☺		☺	☺						☺	☺	☺
Consistency		☺		☺									☺

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Ref	FB/GS/01

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to the standard as required by the University of Witwatersrand.

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