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App-based intervention for children with reading difficulties: A description of five cases

Student: Gaby Kaplan

Student number: KPLGAB002

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Supervisor: Dr Michelle Pascoe

Co-supervisor: Dr Michal Harty

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Abstract

This descriptive single subject intervention study aimed to describe the outcomes of an application (app)- based intervention for five children with reading difficulties. All participants were required to have a grade one reading level. Each participant's language and literacy profiles are detailed in accordance with developmental and information processing models, and intervention was designed based on each child's specific level of difficulty. Following a baseline control period, each child received approximately six weeks of intervention using the Reading TherAppy and/or Comprehension TherAppy app (Tactus Therapy Solutions) on an iPad® mini, which was mediated by the researcher on a 1:1 basis. Treated and untreated probe items were administered at three points in the study (baseline, pre, post) in order to determine the effects of intervention on treated and untreated, matched items. Each child's reading on standardized literacy measures was re-evaluated post intervention. This was followed by an interview with each participant to obtain information about his or her experience of the intervention. Results show that all participants improved their reading of items treated in the intervention. In addition, some of the participants' standardized reading and spelling scores improved in relation to typically developing peers from pre to post intervention testing. Changes are detailed for each participant using the theoretical models. Child interviews indicated that all children enjoyed a positive experience of intervention. This study aimed to explore and contribute to the limited knowledge base on efficacy, optimal dosage and outcomes of app-based intervention for children with reading difficulties. The implications of the study are discussed in relation to Speech Language Therapists working in educational settings, the functional application of models of reading, and the reading intervention literature.

Key words: app-based intervention, reading, models of reading, speech language therapy.

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Abbreviations

AAC – Alternative and augmentative communication

App – Application

CPD - Continued Professional Development

DRC - Dual Route Cascade model

DoE - South African National Department of Education

PA – Phonological awareness

PIRLS - The Progress in International Reading Literacy Study

RAN - Rapid Automatized Naming

SLI - Specific Language Impairment

SLT - Speech-Language Therapist

TIMSS - The Trends in International Mathematics and Science Study

Conventions

7; 5 in this study, refers to the child's chronological age (i.e. 7; 5 = 7 years; 5 months)

Grade R in this study, refers to Reception year; the year prior to onset of formal schooling in grade 1.

CHAPTER ONE: OVERVIEW OF READING AND INTERVENTION

1.1. INTRODUCTION TO CHAPTER:

There is a widely acknowledged and urgent need for literacy intervention in South African schools (Jordaan, 2011; Kathard et al., 2011; Navsaria, Pascoe & Kathard, 2011; Wium & Louw, 2013). The literacy crisis in South Africa has been shaped to a large extent by the country's history of oppression. A segregated education system was enforced during the Apartheid era, which meant that learners of colour received a vastly poorer quality of education than their white counterparts (Kathard et al., 2011).

In 2003, the Department of Education investigated the literacy levels of grade 3 learners and found that 61% were not reaching the appropriate grade level outcomes (Centre for Evaluation and Assessment, 2006). These poor reading levels were also highlighted in The Progress in International Reading Literacy Study (PIRLS, 2006), which compared international reading levels of grade 4 learners across a range of countries (Howie, Venter, van Staden, Zimmerman, Long, du Toit, Scherman & Archer, 2008). It was found that the reading levels of South African learners were well below international standards. A more recent report on the Annual National Assessment of 2011 (Department of Basic Education, 2011b) presented the results from language and mathematics assessments of 6 million learners from grades two to seven, as part of a quality improvement strategy (Kathard et al., 2011). It was found that only 12 – 31% of these learners had 'achieved level of performance', with the lowest outcomes from poor and rural communities. These studies provide evidence that the quality of education in South Africa is in critical need of improvement.

This chapter aims to expand on literacy in the South African context and the role of Speech Language Therapists (SLTs) in education and literacy development. Models of reading will be briefly introduced, and then will be discussed in further detail in Chapter two of this thesis. Principles of intervention and intervention studies will also be reviewed. This will be followed by a discussion

of intervention dosage and technological interventions for reading comprehension. The present study aims to contribute to knowledge about intervention for children with reading comprehension difficulties in South African schools.

1.2.LITERACY IN THE SOUTH AFRICAN CONTEXT:

In this section, South Africa's history of colonialism and apartheid will be discussed in order to provide a backdrop for understanding the current situation of education in South Africa. The discussion will then progress to post-apartheid South Africa and the reasons why the majority of South African learners are under-achieving at school. These reasons include: the two separate school systems, second language learning and inclusive education. This section will conclude with a look at the role of SLTs in education and how SLTs need to better align their intervention with the curriculum and assist both educators and learners in meeting their learning outcomes.

1.2.1 Historical perspective on Education in South Africa:

The current weakness of South Africa's education system was influenced by a long history of colonialism and apartheid (Fleisch, 2008; Kathard et al., 2011). A history of colonialism created an ethos that devalued the indigenous cultures, and developed the false notion that indigenous people were inferior to the white colonialists. From 1961 to part of 1994, South Africa was under the rule of apartheid – a period defined by racial segregation, inequality and injustice (Fleisch, 2008; Kathard et al., 2011; Navsaria et al., 2011). This culture of imposed segregation was also reflected in the education system, which was separated into two different school systems – the education for those who were white and education for those of colour (Fleisch, 2008; Kathard et al., 2011; Navsaria et al., 2011). More finances were allocated to the white education system, and as a result, these learners benefited in all aspects of education (Kathard et al., 2011). In severe contrast to this, the Bantu Education Act of 1953 was designed to provide an inferior education to learners of colour (75% of the population) in order to keep the majority of the population oppressed and disempowered. Poorly resourced schools, overcrowded classrooms and

inadequate training of teachers characterized the Bantu education system - creating a substandard education for the majority of the population (Fleisch, 2008; Kathard et al., 2011).

During this period there was further segregation of mainstream and special schooling. Large numbers of learners with special needs were excluded from mainstream schooling, dividing the education system further. The issue the education system faces in post-apartheid South Africa is that teachers who were trained for apartheid education continued to teach in post-apartheid education, without the necessary support and training (Kathard et al., 2011; Navsaria et al., 2011). This has perpetuated the cycle of a poor education system, even in post-apartheid South Africa, with a constitution that insists on equality for all.

1.2.2 Education in post-apartheid South Africa:

After the first democratic elections of 1994, South Africa emerged as democracy. The new constitution put forward the values of equality and freedom and led the way to a changed political landscape. Along with the human rights chapter of the constitution, which insisted upon equality, freedom and dignity for all, there was a global drive to eradicate illiteracy and to facilitate further scientific inquiry and knowledge in the field of education (Fleisch, 2008; Kathard et al., 2011). One of the main priorities of the new government was to strengthen Basic Education, and a number of policies were created to facilitate this and to ensure equality for all learners (for example, the South African Schools Act [Department of Education, 1996b], The National Education Policy Act [Department of Education, 1996c] and The National Norms and Standards for School Funding [Department of Education, 1998]).

However, despite the efforts made to right the wrongs of the past, there is evidence from a number of government initiatives and global studies that the South African education system is still suffering (Fleisch, 2008; Kathard et al., 2011; Navsaria, 2011). International studies such as The Trends in International Mathematics and Science Study (TIMSS) (Howie, 2005a), and the previously

mentioned PIRLS (2006) compared South African learners with learners from other countries and found significant weaknesses in literacy and numeracy. Although there have been criticisms about cross-national comparisons and the unfamiliarity of standardized testing in South African schools, the fact that South Africa performed so poorly is an indicator of weakness in the learning areas tested (Fleisch, 2008).

On a national level, the Systematic Evaluation of the Foundation Phase (2003) was conducted with 51, 000 of the nation's grade 3 learners. Learners were randomly selected in order to gather baseline information on learners, schools and learning areas (namely literacy, numeracy and life skills) in the first three years of schooling (Fleisch, 2008). This study found that performance in these learning areas was below the standard required. The grade 3 learners had a very poor understanding of basic mathematics (average score of 30% on numeracy tasks). For literacy, the average score for all learners tested was 54% (Fleisch, 2008). When oral versus written domains of literacy were further examined, it was found that learners achieved an average score of 39% on reading and writing tasks, which once again highlighted the very poor levels of literacy amongst learners (Fleisch, 2008). In 2005, the Department of Education (DoE) made public the results from the Grade Six Systematic Evaluation, which showed that only 28% of learners were achieving at or above grade-level requirements – therefore two-thirds of the learners were not meeting the basic literacy and numeracy requirements of grade 6 (Fleisch, 2008). On closer inspection of these poor outcomes, many concerns were raised about the achievement gap between advantaged and disadvantaged learners.

These concerns of inequality in the education system were supported by a government initiative in the Western Cape that found a significant achievement gap in learners from advantaged and disadvantaged schools. Every primary school in the Western Cape with five or more grade 6 learners (34 596 learners) was included in an assessment to determine the number of learners achieving grade-level competency in literacy and numeracy (Fleisch, 2008). Results showed that only 35% of these learners were performing at grade-appropriate

levels (Fleisch, 2008). Results were then disaggregated to demonstrate the significant achievement gap between learners from former 'white schools' and those from former 'schools of colour'. It was found that almost four out of five learners from former 'white schools' were at a grade-appropriate level; while only one in four learners from former 'schools of colour' achieved this level (Fleisch, 2008). This study highlighted the disparity between the achievement levels in different schools – that is, a significant achievement gap between those schools who were previously under the white education system, and those schools who were previously under the Bantu education system. Therefore, despite political reform and an effort to provide equal education to all learners, segregation from the country's apartheid past is still an issue and barrier to improving the education system.

The previous section dealt with the inequalities of education received by the advantaged former white schools and the disadvantaged former schools of colour and how this has contributed to the poor achievement levels of the majority of South African learners. This next section will explore another inequality in the South African education system - that is, the issue of language and learning.

Another main problem in education is that the majority of learners are receiving education in English, which is not their first language (Alexander, 2005; Brock-Utne & Skattum, 2009; Fleisch, 2008; Heugh, 2009; Jordaan, 2011). Less than one in ten South African children speaks English as their first language, however by the end of grade 3, most learners receive instruction and evaluation in English (Fleisch, 2008). A growing number of educational researchers agree that learning in a second language (in this case, English) is one of the main reasons why learners fail to achieve at school (Alexander, 2005; Brock-Utne & Skattum, 2009; Pladdeman, Vuyokazi & Ncedo, 2010, in Webb, Lafon & Pare, 2010). In the TIMSS (1999), which evaluated 900 grade 8 learners, South African learners obtained an average score of 264 compared to an international average of 467 (Howie, 2005a). Howie explained this significant gap, by stating that fluency in English was the most significant factor in learning science and mathematics.

This trend is consistent with national findings of the Western Cape Grade Six 2003 assessment study, which found that first language English speakers received a mean score of 70% on a literacy test, whereas first language isiXhosa speakers received a mean score of only 37%. These studies showed that although speaking English as a first language does not guarantee success and achievement at school, it is a strong predictor (Fleisch, 2008).

Broom (2004) reported on findings of the language and performance of grade 3 learners in Gauteng. A cross-section of 20 schools in the Gauteng district participated in this study in which there was considerable variation of the learners' first language. Within the urban township schools, where none of the learners spoke English as their first language, a range of three to seven languages was spoken in the classrooms. Within the former white schools, there was an equal mix of languages spoken. This study highlighted that multilingualism existed in all of the urban classrooms, in both advantaged and disadvantaged schools alike. There was considerable variation in language practices and resources at these schools. Children performed better in their first language as opposed to their second language and children from previously advantaged schools performed better in their second language compared to those from disadvantaged schools. Some factors that contributed to the improved performance of advantaged learners were exposure to English in their environments; being taught by native English speakers; and greater access to English reading materials and resources. In the township schools, where the language of learning and teaching in the Foundation Phase (grades R – three) was isiZulu, Setswana or Sesotho, the shift to English was made before or during grade 4. Therefore, not only were these children not immersed in English in their environments, they were also only instructed and assessed in English at a later stage of their schooling.

A relationship between achievement and learning in one's first language has been well established in the literature. However, Fleisch (2008) cautions against making any generalized statements that learning in a second language is definitively responsible for poor learner achievement. He recommends that

more randomized controlled trials are needed to understand the 'generative mechanism' - the underlying reasons and causes that explain *why* second language learners are underachieving (p. 104). More research is also needed to better understand issues related to how poverty, poor health and the quality of teaching and teacher training affects learner achievement.

This section has dealt with some of the issues that the education system faces in post-apartheid South Africa. Despite enlightened policies, the majority of South African learners are underachieving. Two of the main contributing factors were discussed - the disparity between the quality of education in former white schools and former schools of colour; as well as the impact that learning in a second language has on learner achievement. The section on literacy in the South African context will conclude by examining the role SLTs play in education and literacy development, and how SLTs can better align themselves with the needs of teachers and learners to assist in achieving their learning outcomes.

1.2.3 The role of Speech Language Therapists (SLTs) in education:

SLTs are currently vastly under-represented in the public education system in South Africa (Kathard et al, 2011; Wium & Louw, 2013). A large contributing factor is that SLTs have not had the opportunity to highlight and demonstrate their roles in supporting general education (Kathard et al, 2011). Within a constrained human resource capacity, SLTs need to develop creative strategies to make visible links between language and learning so as to align themselves with general education (Kathard et al, 2011; Lewis, 2004; Wium & Louw, 2013). Language is an integral part of communication and a prerequisite for the development of reading and writing (Bohlmann & Pretorius, 2002; Owens, 2002). The functions of language also extend to other learning areas, such as imagination, creativity and the promotion of science, technology and environmental knowledge (Kathard et al., 2011). Therefore, language is a medium of communication and education in *all* learning areas. Under-developed language skills will negatively impact on a learner's academic achievement and psychosocial development (Bohlmann & Pretorius, 2002).

The conceptual separation between the domains of teachers and SLTs means that SLTs are most often associated with the domain of spoken language. However, the majority of research suggests that spoken and written language should be viewed on a continuum, with spoken language as the foundation upon which written language is developed (Bishop & Snowling, 2004; Pascoe, Stackhouse & Wells, 2006; Snowling & Hulme, 2012; Stackhouse & Wells, 2001). Phonological awareness acts as the connecting link between the two domains (Pascoe et al., 2006). Therefore, SLTs working in the classroom environment are required to focus on spoken language, written language and phonological awareness. Making this visible connection between language and learning is particularly important in aligning the goals of SLTs and teachers and ultimately assisting all parties in meeting learning outcomes (Kathard et al., 2011; Wium & Louw, 2013). This section will introduce some of the changes and challenges that SLTs face working in the education system and then focus on the various collaborative roles that SLTs are required to play in the South African school system. The connections between language and learning have been briefly introduced here and will be discussed in detail in the next section.

Together with South Africa's political changes, the education system has changed dramatically over the past two decades (Kathard et al., 2011; Navsaria et al., 2011; Wium & Louw, 2013). One such change made by the DoE was the dramatic reduction of SLT posts in schools (Wium & Louw, 2013). This resulted in an increased number of private practitioners who were tasked with addressing the communication difficulties of school-aged children (Wium & Louw, 2013). A disadvantage of this is that these private practitioners are not easily accessible to the majority of the population because they are remunerated by medical aid schemes and/or parents who can afford their fees. The traditional 'pull-out' model, in which the child as opposed to the system is the target of intervention and learners are identified based on their presenting difficulties/deficits, is no longer appropriate and needs to be replaced with a collaborative, inclusive model of service delivery (Kathard et al., 2011; Wium & Louw, 2013). This is supported by the inclusive education policies that are now

in place, that require the SLT to work with a range of communication difficulties (Kathard et al, 2011; Wium & Louw, 2013). With this inclusive classroom-based approach, the scope of the profession has also expanded, because SLTs now need to address all learners in the classroom, not just those who have an identified speech or language difficulty (Wium & Louw, 2008). The classroom environment is further complicated by language issues, such as second language learners, multilingual classrooms, and a lack of professionals who are proficient in African languages (Fleisch, 2008; Kathard et al., 2011; Wium & Louw, 2013). In order to best overcome these challenges and historical influences, SLTs need to play a highly collaborative role with both teachers and learners, at a district and strategic level (Wium & Louw, 2013).

This collaborative approach, as recommended by the DoE, advocates that SLTs be involved in identifying and addressing barriers for the learner, teacher, curriculum and institutional institution (Department of Education, 2001b). In order to support learners, SLTs are required to provide a preventative and supportive role. Inclusive education advocates that support of language and learning should be provided to all learners, not just those who are already experiencing difficulties (Wium & Louw, 2013). This requires the SLT to be actively involved in developing, managing and evaluating learners' progress according to their developmental level and ability (Wium & Louw, 2013). SLTs should identify those who are *at-risk* for language and learning difficulties, with the aim of addressing risk factors as early as possible to prevent later learning difficulties. Ideally, preventive strategies should be implemented before the child enters the school system (ASHA, 2010), however in the South African context this is not always possible (Kathard et al., 2011; Wium & Louw, 2013). In South Africa, preventive activities should focus on providing language and literacy intervention in the school system as early as possible, that is, to preschool and foundation phase learners (Wium & Louw, 2013).

Collaboration with teachers is particularly important because of the connection between language and learning. This collaboration should aim to close the conceptual gap between the separation of the domains of teachers and the

domains of SLTs, the latter often being associated only with spoken language (Kathard et al., 2011). However, an extensive body of literature (Bishop & Snowling, 2004; Stackhouse & Wells, 1997) suggests that spoken and written language should be viewed on a continuum, with spoken language as the foundation upon which written language is developed. Since language, literacy and learning are so closely linked, it is imperative that SLTs and teachers support one another in assisting learners to acquire literacy and share professional knowledge (Wium & Louw, 2013). The support of teachers is a vitally important ingredient in high quality early childhood development programmes, and SLTs have a powerful role to play here (Riley & Roach, 2006). The provision of continued professional development (CPD) activities is a form of support that SLTs can provide to teachers (Wium & Louw, 2011). By supporting the professional development of teachers, SLTs can contribute significantly to learners' achievement, particularly for learners from low socio-economic backgrounds (Johnson, Mims-Cox & Doyle-Nichols, 2006). Together with CPD opportunities, SLTs need to engage with teachers in case discussions and consultations.

In order for SLTs to play a collaborative role in the school system, they need to have an understanding of the roles of all professionals working at the school (for example, school psychologists, social workers, occupational therapists), including the parents who are key to supporting the overall social, emotional and academic development of the child (Wium & Louw, 2013). However, engaging parents in the process is challenging in the South African context, as parent involvement is often lacking in families of low socioeconomic backgrounds (O'Connor & Geiger, 2009). SLTs who work in schools are part of the school community as well as the community as a whole (Wium & Louw, 2013). Therefore they are responsible for providing information to parents and school governing bodies about how they can support the learners and the school (for example, raising funds and giving donations). SLTs can also assume leadership positions whereby they provide training and mentoring to new, inexperienced colleagues (Wium & Louw, 2013). Providing clinical supervision for university students and engaging in research opportunities is important for the SLT in

maintaining evidenced based practice and contributing to professional development (Wium & Louw, 2013).

Teachers also have a responsibility to contribute to the collaborative efforts of the SLT, one of which is consulting on curriculum matters. It is the responsibility of the teacher to guide the SLT in curriculum matters so that there is synergy between the themes and events in the classroom and those in therapy (Wium & Louw, 2013). With the shift toward an inclusive approach to intervention, SLTs are required to provide services to larger groups of children using a whole-classroom approach (Bauer, Iyer, Boon & Fore, 2010). Therefore teachers can advise SLTs about managing larger groups. The collaborative role of teachers requires them to allocate time in their schedules to discuss particular learners, learning outcomes and how these can be achieved (Wium & Louw, 2013). This will also enable SLTs and teachers to identify learners who are at risk for language and learning difficulties, which ties in with their preventative roles (Wium & Louw, 2013).

Although there is a move towards collaborative practice in the schools, teamwork between teachers and SLTs has its challenges and it is still in the process of developing. Some teachers are positive about it, whereas others are less enthusiastic to include SLTs in the classroom (Du Plessis & Louw, 2008). In order for collaboration to be successful, teachers and SLTs need to have a clear understanding of the roles, functions and importance of both disciplines (Wium & Louw, 2013). Ultimately, collaboration will enable all parties to share their knowledge and expertise, which will be of maximum benefit to the learner (Wium & Louw, 2013).

There is also scope for SLTs to be involved in higher levels of education at the district and institutional levels. At the district level, SLTs can assist in developing support programmes for teachers in order to encourage carryover of a more language-based, phonetic approach into their classroom teaching. SLTs, together with a team of professionals, can visit schools on a rotational basis in order to identify at-risk learners and learners who are struggling to cope in the

classroom. At an institutional level, SLTs should participate in strategic planning and aim to increase awareness about the profession and the profession's role in education. By inserting themselves into provincial and national levels of the education system, SLTs can contribute to policy development and change, which in turn may impact their roles in the schools (Wium & Louw, 2013).

SLTs need to continue to advocate for more SLT positions in schools, which is currently the case as the South African Speech-Language-Hearing Association (SASLHA) is participating in these discussions with the DoE (Wium & Louw, 2013). Roles at the institutional level of education have important implications for curriculum development as well as for providing at-risk and failing learners with the correct support and services they need. Ultimately, professionals at this level have the opportunity to make an impact on education on a greater scale and have a more extensive reach to create positive change in the system. The changing role of SLTs requires that university training curricula are reflective of these changes, so as to prepare new graduates to deal with these issues and to develop new service delivery methods, such as independent school based clinics (Kathard et al., 2011).

This section has examined the ways in which the roles and responsibilities of SLTs need to change to best align themselves within the realm of general education. This includes addressing the needs of all learners using a whole-classroom based approach, and ultimately contributing to curriculum development and strategic planning at a higher level. As there is a shortage of SLTs in schools, SLTs and their professional bodies need to continue to promote the profession and advocate for the importance of SLT posts in the school system. SLTs should aim to become involved at the provincial and national levels in order to influence policy making to increase SLT posts in schools.

To summarize, section 1.2 explored the various components that relate to literacy in the South African context. The historical influences of colonialism and apartheid were first discussed. This resulted in vast inequalities between

advantaged and disadvantaged learners, which continue to persist today. This, together with issues around second language learning, lack of resources and inadequate teacher training has contributed to the low levels of learner achievement that have been found in national and international studies alike. The discussion then progressed to the roles and responsibilities of SLTs in education, which was previously considered to only be the domain of teachers. The literature suggests that SLTs need to highlight their roles in education by making visible links between language, literacy and learning. Collaboration and engagement with learners, teachers, the curriculum and higher levels of education will enable SLTs to make significant contributions to maximizing learners' achievement. The link between language, literacy and learning was briefly introduced here, however this will be discussed in detail in the next section.

1.3. LANGUAGE, READING AND LEARNING:

In this section the connection between oral language, reading and learning will be elaborated on. First, the influence of oral language on written language will be considered, followed by consideration of the role of phonological awareness (PA) in literacy development. The discussion will then progress to defining reading comprehension and the component skills involved in this process. Bishop and Snowling's (2004) model of reading will introduce this concept.

1.3.1 The link between oral language and written language:

Human language has evolved over thousands of years and has become part of our genetic make-up (Wolf, 2008; Wolf, Ullman-Shade & Gottwald, 2012). Infants are wired to acquire oral language by tuning in to and learning from the language they are exposed to in their environments (Owens, 2002; Pascoe, Harty & Le Roux, 2014; Wolf, 2008). The first three years of life form the critical period for rapid language development and growth, so much so that children have nearly mastered most of the language structures and complexities by this stage (Chomsky, 1957; Owens, 2002; Pascoe et al., 2014; Pinker, 1994; Wolf, 2008). The acquisition of written language on the other hand requires effort, instruction

and repeated practice, as human brains are not so evolved for this purpose (Norton & Wolf, 2012; Wolf, 2008).

When a child enters the school system for the first time, they rely on their oral language skills as the foundation to support literacy development (Pascoe et al., 2014). In-built neural plasticity allows the child to develop reading by forming new connections between parts of the brain that are responsible for other functions, such as language, vision and attention (Norton & Wolf, 2012; Wolf, 2008). Therefore, any problem with the development of oral language will have an effect on the development of written language, that is reading and writing (Pascoe, 2006; Pascoe et al., 2014). This in turn will hinder the growth and expansion of language derived from written text, for example more advanced vocabulary and concepts.

The relationship between oral and written language has been well established and documented in the literature (Catts, Bridges, Little & Tomlin, 2008; Nation, Cocksey, Taylor & Bishop, 2010; Nation, Snowling & Clarke, 2007; Pascoe et al., 2014; Snowling & Hulme, 2010; Wolf, 2008) – that is, children who have typically developing oral language skills usually acquire normal reading ability, whereas those children with difficulties with oral language often experience problems with learning to read. Therefore, it is clear that children with language disorders or second language learners (Kathard et al., 2011; Fleisch, 2008) would be at risk for written language difficulties. Learning in a second language (discussed in section 1.2.2.) may increase the risk of poor academic and literacy achievement. In terms of the effects of language disorders on reading, this will be made clearer when Bishop & Snowling's (2004) model of reading comprehension is discussed in the reading comprehension section that follows below.

Although a foundation of oral language is important for the development of written language, and reading in particular, children still need to learn how to access this written language system. Phonological awareness plays a vital role in enabling the child to do so by establishing concrete representations between sounds and letters.

1.3.2. The bridge between oral and written language: Phonological Awareness:

Phonological awareness (PA) can be defined as “the ability to reflect on and manipulate the structure of spoken language (e.g. into words, or syllables or sounds) (Pascoe et al., 2006, p. 240). PA tasks include rhyme, syllable and sound (phoneme) segmentation, blending and manipulations. Children need to develop PA skills in order to understand the alphabetic texts and principles of spoken language (Gillon, 2004; Pascoe et al., 2006; Sutherland & Gillon, 2007; van Bysterveldt, Gillon, Moran, 2006). For example, children learn that the sounds (consonants and vowels) in a word can be represented in written forms (i.e. letters).

There are developmental principles that inform how children acquire PA skills. Firstly, as children grow older they develop the ability to perceive smaller and smaller parts of sound – that is, children can detect syllables before they can detect onset and rimes, and can detect onset and rimes before they can detect single phonemes and this is universal across all languages (Anthony & Francis, 2005). In addition to this developmental principle, it is believed that children can perceive similar and dissimilar sounding words before they can manipulate phonemes within words. Similarly, they are able to blend phonological information before they can segment it. Children then refine each PA skill as they learn new ones.

Before a child learns to read, they need to be able to segment/break up sounds and syllables in spoken words. This skill is then carried over into reading tasks, when a child needs to recognize letters/letter combinations and sound these out and blends these into words, which is known as decoding. A good grasp of PA skills means that the child has a strong foundation of segmental representations upon which phonological (sound) and orthographic (letter) representations can be mapped to support decoding of words (Hulme et al., 2002). This system supports generalization (Harm & Seidenberg, 1999) and enables children to read

both new and familiar words that follow the phonetic-orthographic rules of the language (Nation & Snowling, 2004). These processes need to become automatic to enable fluent reading and reading with understanding (Wolf, 2008; Wolf et al., 2012).

Oral language also plays an important role in the development of PA. For example, the linguistic properties and complexities of spoken language – such as word structures, phoneme positions and articulatory factors - influence the development of PA (Anthony & Francis, 2005). The development of some PA skills prior to formal literacy instruction is also suggestive of the significant influence of oral language on PA development (Gillon, 2002, 2004; Anthony & Francis, 2005). With all of this in mind, the connection between PA and reading and spelling is obvious and together with letter knowledge, is a strong predictor of reading outcome (Anthony & Francis, 2005; Wolf, 2008; Wolf et al, 2012; Norton & Wolf, 2012; Pascoe et al., 2006).

The conceptual separation between the domains of teachers and SLTs means that SLTs are most often associated with the domain of spoken language. However, the majority of research suggests that spoken and written language should be viewed on a continuum, with spoken language as the foundation upon which written language is developed (Catts, Bridges, Little & Tomlin, 2008; Nation, Cocksey, Taylor & Bishop, 2010; Nation, Snowling & Clarke, 2007; Snowling & Hulme, 2010). Phonological awareness acts as the connecting link between the two domains (Pascoe et al., 2014). Therefore, SLTs working in the classroom environment are required to focus on spoken language, written language and phonological awareness. The connection between these skills will be discussed in greater detail later on in the chapter.

The relationship between phonological awareness, oral language and reading is an important one and has been well established in the literature. Difficulties in PA and phonological processing represent the most well known cause of reading difficulties (Gustafson, 2000; Wolf, 2008; Wolf et al., 2012). In summary, PA bridges the gap between oral and written language systems by providing

concrete representations of sounds and sound segments (Pascoe et al., 2014). However, the non-phonetic nature of the English language means that many words contain irregular spelling rules, or exception words. Therefore children need a system to read these irregularities in written language - which is achieved by learning word recognition strategies.

1.3.3. Word recognition and reading:

The English language has many irregularly spelt 'exception' words that cannot be read by means of letter-sound mapping. Relying solely on phonological awareness and letter knowledge to decode a word is not always effective or appropriate. For words containing such irregularities, children need to acquire a word recognition system that contains an inventory or knowledge system of the irregular nature of English spelling. Although the important role of PA in the development of decoding is undeniable, the skills that are required for word recognition are less well understood (Nation & Snowling, 2004). However, there are a number of theories about the cognitive and linguistic processing in word recognition tasks, which have been represented in various models mapping the real-time information processing of written language (e.g. dual route, connectionist and analogy models). This will be elaborated on in Chapter two, when information-processing models and developmental models of reading are discussed.

In essence, an oral language foundation, phonological awareness, decoding and word recognition are all necessary components in the process of reading. However, the ultimate goal of learning to read is to be able to understand written language, to make meaningful connections with one's own world knowledge and ultimately to be able to learn and expand one's knowledge through reading.

1.3.4. Reading and reading comprehension:

The ultimate goal of reading is to be able to understand what is being written. This opens up a world of communication, learning opportunities and growth, for

example, higher education (Nation & Norbury, 2005; Pascoe et al., 2014; Wolf, 2008). Reading comprehension requires the complex interaction of a number of cognitive and language processes, from recognizing letters and words, to attaching meaning and understanding in context (Perfetti, Landi, & Oakhill, 2005; Wolf, 2008).

Being able to decode a word is a necessary first step in reading, but it does not guarantee that adequate comprehension will follow. Nation and Norbury (2005) highlighted the distinction between two components of reading – these being the process of deciphering/decoding the written text as well as the process of understanding the text. This relationship between decoding words and comprehension has also been represented by Bishop and Snowling’s (2004) two-dimensional model (see Figure 1), which was based on Hoover and Gough’s Simple View of Reading model (1990) and an extension of the model proposed by LaBerge and Samuels (1974). These models represent how decoding and phonological skills interact with language comprehension skills to describe different types of reader profiles. For example, a child who has reading comprehension difficulties may have a problem with decoding, e.g. dyslexia (quadrant A); language comprehension (quadrant D); or both (quadrant C).

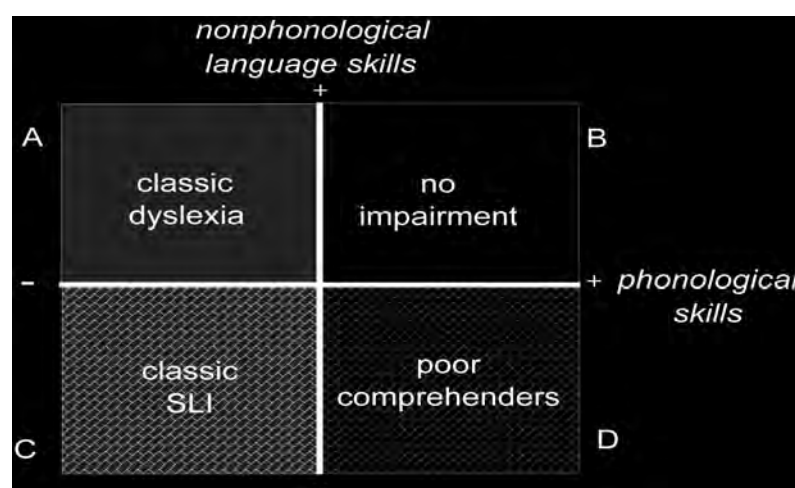


Figure 1: Bishop and Snowling’s simple view of reading model (2004) showing the relationship between decoding and linguistic comprehension for reading.

Readers utilize different information processing approaches/models depending on their level of development (Sabatini, Albro & O'Reilly, 2012). Younger readers typically use lower level processing, or a bottom up approach to reading (Sabatini et al., 2012), that is, the systematic processing of letters and words (decoding and word identification). Therefore readers who are using a bottom up approach will find that the difficulty level of a text increases as word and sentence length increases, as there are more units (i.e. letters and words) to process (Perkins, 2001). Older readers use more of a top down approach to reading where they process the text as a whole, and extract meaning based on prior world knowledge (Perkins, 2001). In order to be a successful reader, we rely on the integration of both approaches. Longitudinal developmental models of reading will be discussed in Chapter two.

Various cognitive component skills have also been found to correlate with successful reading comprehension, and these include text integration, metacognitive monitoring and working memory (Oakhill, Cain & Bryant, 2003, p. 443). An influential study by Norton and Wolf (2012) introduced the idea of the brain's "reading circuit" which involves the rapid integration of a number of neural systems to support successful reading. This reading circuit is able to support every aspect of language (e.g. morphology, syntax, phonology, semantics and pragmatics) as well as other relevant cognitive processes, such as working memory, attention, visual and motor skills, as well as higher level language and cognition (Norton & Wolf, 2012; Wolf, 2008). This informed the concept of fluent comprehension that describes "a manner of reading in which all sublexical units, words, and connected text and all the perceptual, linguistic, and cognitive processes involved in each level are processed accurately and automatically so that sufficient time and resources can be allocated to comprehension and deeper thought" (Norton & Wolf, 2012, p. 429; Wolf, 2008).

Reading involves the complex interaction of multiple linguistic and cognitive processes, and depending on a reader's level of development, will require bottom-up (decoding and word recognition in younger readers) or top down (metalinguistic skills in older readers) processing skills. It is the goal of every

reader to be a fluent comprehender in which a well-integrated system of automatic processing and fluent reading enables higher-level comprehension. In this study, the integrated cognitive, decoding and linguistic processes of reading comprehension will be referred to as reading, unless otherwise specified.

1.4. READING INTERVENTION:

Intervention, or therapy, aims to bring about long lasting changes and improvement in a targeted skill. The ultimate goal of intervention research is to determine whether an intervention works by considering the outcomes of the intervention. This section will define the terms used to describe intervention outcomes and explain the stages of intervention research as recommended by Robey and Schultz (1998). This will be followed by a review of the literature on reading intervention studies. The chapter will close with a look at intervention dosage and app-based technological interventions for reading.

1.4.1 Intervention research:

One of the most important parts of the intervention process is evaluating the outcomes of the intervention (Pascoe et al., 2006). Therefore, the therapist needs to determine if he/she is doing the best for the client and maximizing the service delivery. There is a constant need in the literature and in daily practice for evidence to substantiate that what we do works and whether it is both time and cost effective (Baker, 2012; Basso, 2005; Enderby, 2012; Pascoe et al., 2006; Schmitt & Justice, 2012).

“An outcome is most simply defined as the result of intervention” (Pascoe et al., 2006, p.306), however the term ‘outcomes’ is the preferred term as it captures the multidimensional effects of intervention, be it clinical, social or functional (Wertz & Katz, 2004). In the intervention literature, the terms efficacy, effectiveness and efficiency are used to describe these outcomes (Wertz & Katz, 2004). Efficacy refers to the intervention outcomes in an optimal or ‘perfect’ situation, for example, at optimal dosage, with optimal levels of support, unlimited access to resources and in a one-on-one setting (Pascoe et al., 2006;

Robey & Schultz, 1998; Wertz & Katz, 2004). This gives one an indication of what the possible benefits may be, as opposed to the actual benefits in a real world situation. Effectiveness describes intervention outcomes in a realistic, practical, real world situation (Pascoe et al., 2006; Robey & Schultz, 1998; Wertz & Katz, 2004). Robey and Schultz (1998) also recommend that effectiveness research should only be conducted once efficacy of an intervention is certain. Lastly, efficiency considers the cost effectiveness and time effectiveness of the intervention (Baker, 2012; Basso, 2005; Pascoe et al., 2006; Robey & Schultz, 1998; Wertz & Katz, 2004).

Robey and Schultz (1998) recommend that intervention research be evaluated sequentially and systematically. They devised a five phase health care model of clinical outcomes research, which is as follows:

Phase I: Develop a hypothesis for an intervention

Phase II: Evaluate the efficacy of the intervention

Phase III: Test the effectiveness

Phase IV: Initial testing of efficiency

Phase V: Continuation of efficiency testing in terms of cost effectiveness and time effectiveness.

This study will consist of the first two phases, which are particularly important in the exploratory stages of research as they allow the researcher to develop a strong foundation upon which further hypotheses can be developed and from which a larger more extensive evaluation can be carried out (Pascoe et al., 2006; Robey & Schultz, 1998). As this intervention is in the initial research phases and exploratory in nature, it is in line with Robey and Schultz's (1998) recommendation for phases one and two. Furthermore, single subject designs are particularly appropriate for the initial phases of the intervention research (Pascoe et al., 2006). Some examples of speech and language intervention studies that have employed a single case design include: Best et al. (n.d) who investigated the intervention effects on naming and related skills in two girls with word-finding difficulties; a study by Baylis and Snowling (2011) that evaluated the effects of a phonological reading intervention on 10 children with

Down's syndrome; and Moriarty and Gillon (2005) who investigated the effects of phonological awareness intervention with three children who had apraxia of speech. Tate et al (2008) have rated the methodological quality of single subject designs and n-of-1 designs and provide further details and examples of levels of evidence in single case designs. If intervention yields positive outcomes, the researcher can proceed to the next phase to examine efficacy and effectiveness more systematically (Pascoe et al., 2006).

1.4.2. Approaches to intervention research: a review of reading intervention studies:

In terms of reading, evidence is available to support the effectiveness of interventions. A review of intervention studies of relevance to this project was undertaken. Studies were selected based on the following criteria:

- (1) The term 'comprehension' and/or 'reading ' appeared in the title or key words of the article
- (2) Participants from preschool to 10 years of age
- (3) Published between the years of 1990 – 2014
- (4) Published in English in peer-reviewed journals.

In this review, both key words 'reading' and 'comprehension' were included as the search terms to reflect the broader definition of reading used in this study – that is, the integration of cognitive, decoding and linguistic processes. This review was conducted using the Google Scholar search engine, with the key search terms 'reading comprehension intervention' and 'reading comprehension therapy'. A total of 315 000 results were generated from this search, of which the 11 most relevant studies were selected for this review. This review did not set out to exclude any studies in which intervention was not successful.

However, no such studies were found since it is often the case that unsuccessful intervention studies are not submitted for publication (Enderby, 2012), despite the valuable contributions they can make to effectiveness research and theoretical knowledge in the field. Any systematic review and meta-analysis

articles were excluded from this search in order to obtain only direct intervention studies. An overview of the papers included in this review is presented in Table 1, which will be followed by more detailed discussion of these papers.

Table 1. Reading and language interventions for children from preschool to grade 3: Overview of papers included in the review

Author/s	Year	Journal
Bowyer-Crane et al.	2007	Journal of Child Psychology and Psychiatry
Clarke, Snowling, Truelove and Hulme	2010	Psychological Science
Denton, Fletcher, Anthony and Francis.	2006	Journal of Learning Disabilities
Guthrie et al.	2006	The Journal of Educational Research
Isbell, Sobol, Lindauer and Lowrance,	2004	Early Childhood Education Journal
Lonigan, Anthony, Bloomfield, Dyer and Samwel	1999	Journal of Early Intervention
Lonigan and Whitehurst	1998	Early Childhood Research Quarterly
McGee and Johnson	2003	Educational Psychology
Oakhill and Patel	1991	Journal of Research in Reading
O'Connor, Harty, and Fulmer	2005	Journal of Learning Disabilities
Tan and Nicholson	1997	Journal of Educational Psychology

The majority of the papers on reading comprehension intervention are published in the field of psychology – specifically childhood and educational psychology – with none from SLT journals. This demonstrates that reading is often housed within an educational and psychological domain, as opposed to that of SLT. There is a pressing need for more SLT driven research in the field, to contribute specialized linguistic and phonological insights to the literature on reading comprehension.

1.4.2.1 Participant characteristics

Sample sizes varied widely in these studies, ranging from 38 – 300 participants. Studies with larger numbers of participants are typically more representative of the population and therefore allow for generalizability, however smaller scale studies allow for more descriptive research and detailed analyses. For example, in the study by Denton, Fletcher, Anthony and Francis (2006) that used a relatively smaller number of participants (N=27), more detailed participant descriptions were given, compared to those in the paper by O'Connor, Harty and Fulmer (2005) in which a larger number of participants were used (N=300).

This variety in the literature suggests a good spread of research designs in the field, which in turn results in a diverse mix of theoretical knowledge for professionals to draw upon.

Some of the papers (i.e. Denton et al., 2006; McGee & Johnson, 2003; O'Connor et al., 2005) chose to examine participants within an age range or grade range, whereas others focused on a singular age or grade. The column labeled 'participant difficulties' refers to the problems that the participants experienced according to the authors. This was often determined by assessment scores that were considered to be below average compared to typically developing peers; or it referred to those children who were at risk for language or reading problems. Most of the participants experienced difficulties with general reading ability, with fewer studies focusing on reading comprehension in particular (Clarke, Snowling, Truelove & Hulme, 2010; McGee & Johnson, 2003). Studies that focused on participants of younger ages (preschool, 2-5 age group) (Bowyer-Crane et al. 2007; Lonigan et al., 1999; Lonigan & Whitehurst, 1998), targeted the receptive and expressive language difficulties of these children. Since language skills contribute significantly to emergent literacy development, they are typically the main focus of assessment and intervention in children of this age group who are at risk for language and later literacy difficulties (Snowling & Hulme, 2012). These studies typically began with a section describing the participants as well as the inclusion and exclusion criteria for the study. An overview of participant characteristics in each of the papers is listed in Table 2.

Table 2. Reading and language interventions for school aged children: participant characteristics

Author/s	Year	N=	Age (years)	Grade	Sex	Participants' difficulties
Bowyer-Crane, Snowling, Duff, Fieldsend, Carroll, Miles, Gotz and Hulme	2007	152	Average 4.9	Not specified	M F	Receptive and expressive language difficulties
Clarke, Snowling, Truelove and Hulme	2010	84	8-9	4	M F	Reading comprehension difficulties
Denton, Fletcher, Anthony and Francis.	2006	27	Average 8.6	1-3	M F	Persistent deficits in reading
Guthrie, Wigfield, Humenick, Perencovich, Taboada and Barbosa	2006	98	Not specified	3	M F	Exposure to low of stimulating reading tasks.
Isbell, Sobol, Lindauer and Lowrance	2004	38	3-5	Preschool	M F	None
Lonigan, Anthony, Bloomfield, Dyer and Samwel	1999	95	2-5	Preschool	M F	Receptive and expressive language difficulties
Lonigan and Whitehurst	1998	91	3-4	Preschool	M F	Receptive and expressive language difficulties
McGee and Johnson	2003	40	6.6 – 9.11	Not specified	M F	Reading comprehension difficulties
Oakhill and Patel	1991	44	9	Not specified	M F	Reading comprehension difficulties
O'Connor, Harty, and Fulmer	2005	300	Not specified	R-3	M F	Reading difficulties
Tan and Nicholson	1997	42	7-10	Not specified	M F	Reading difficulties

1.4.2.2 Supporting theories:

The studies included in this review used a range of different theoretical standpoints and motivations to guide their interventions as shown in Table 3.

Table 3. Reading and language interventions for school aged children: Supporting theories

Author/s	Year	Supporting theories
Bowyer-Crane, Snowling, Duff, Fieldsend, Carroll, Miles, Gotz and Hulme	2007	Gough and Tunmer (1986)
Clarke, Snowling, Truelove and Hulme	2010	Beck, McKeown and Kucan (2002), Ehrlich, Remond and Tardieu (1999), Johnson-Glenberg (2000) and Yuill and Oakhill (1988).
Denton, Fletcher, Anthony and Francis.	2006	Torgesen, Rashotte and Alexander (2001) and Simos et al. (2002)
Guthrie, Wigfield, Humenick, Perencivich, Taboada and Barbosa	2006	Guthrie and Wigfield (2000)
Isbell, Sobol, Lindauer and Lowrance,	2004	Sobol (1992)
Lonigan, Anthony, Bloomfield, Dyer and Samwel	1999	Lonigan and Whitehurst (1998)
Lonigan and Whitehurst	1998	Whitehurst et al. (1994).
McGee and Johnson	2003	Yuill and Oakhill (1988)
Oakhill and Patel	1991	Oakhill (1982) and Oakhill, Yuill and Parkin (1989)
O'Connor, Harty, and Fulmer	2005	O'Connor, Fulmer, Hartey and Bell (2005)
Tan and Nicholson	1997	LaBerge and Samuels (1974), Perfetti (1977) and Perfetti and Hogaboam (1975)

The papers by O'Connor et al. (2005) and Tan and Nicholson's (1997) were underpinned by a phonological, decoding perspective, whereas those theories in papers by Oakhill and Patel (1991) and Isbel, Sobol, Lindauer and Lowrance (2004) were generated from a linguistic standpoint. A more recent study by Bowyer-Crane et al. (2007) revisited this contrast by distinguishing between a phonological and linguistic based intervention. Studies that focused on children in the preschool phase (Lonigan & Whitehurst, 1998; Lonigan et al., 1999) were also positioned within a linguistic framework, which is appropriate considering that language and emergent literacy skills are generally the focus of intervention in this population.

More recent theories have supported the role of higher-level metacognitive and metalinguistic skills training in reading comprehension intervention, as featured in studies by Clarke et al. (2010) and McGee and Johnson (2003). However in the more recent of the two, the study by Clarke et al. (2010) found that integrating oral language activities with these text comprehension strategies was also beneficial for children with reading comprehension difficulties. Another more current theory in the paper by Denton et al. (2006) emphasized the

importance of reading fluency. This ties into Norton and Wolf's (2012) notion of fluent comprehension, discussed in a previous section, in which a well-integrated, fluent reading circuit enables a greater amount of cognitive resources to be freed up for comprehension of text. Together with a focus on comprehension, Guthrie et al (2006) also considered the psychological factor of motivation, which was supported by the theoretical framework of Guthrie and Wigfield (2000).

Few papers gave an explicit rationale for using a particular theoretical standpoint, with exceptions being Guthrie et al (2006) and Tan and Nicholson (1997). Many authors based their research on previous studies done by other researchers in the field (Isbell et al., 2004; Denton et al., 2006; Clarke et al., 2010), as opposed to testing out or extending a particular or historical theory on reading comprehension. Therefore, these authors often generated their own theories that they then researched.

1.4.2.3 Intervention:

A number of component skills of reading were addressed in the interventions and a variety of approaches were used to do this. These are summarized in Table 4 where it is shown that all interventions had successful outcomes. Here, the 'Outcomes' column refers to the areas/skills that were evaluated after the intervention; and the 'Results' column refers to the findings of the intervention for each outcome. As each study reported the results in different ways, it was often difficult to compare the results.

Table 4. Reading and language interventions for school aged children: Interventions, outcomes and results.

Study	Year	Intervention	Outcomes	Result
Bowyer-Crane, Snowling, Duff, Fieldsend, Carroll, Miles, Gotz and Hulme	2007	Phonology with reading (P + R) or oral language (OL).	Phonological awareness, oral language and literacy (decoding, reading comprehension, spelling)	Training using the P + R intervention improved decoding ability, which generalized to reading of novel words. The OL intervention improved vocabulary and grammatical skills.
Clarke, Snowling, Truelove and Hulme	2010	Text-comprehension (TC) training, oral-language (OL) training, and TC and OL training combined (COM).	Reading comprehension and vocabulary	All intervention groups made significant improvements in reading comprehension and were maintained at follow up. The OL and COM groups also demonstrated significant improvements in expressive vocabulary, with generalization to untreated words in the OL group.
Denton, Fletcher, Anthony and Francis.	2006	Reading: decoding and fluency	Decoding, fluency, spelling and comprehension	Improved decoding, fluency and comprehension on standardized assessments
Guthrie, Wigfield, Humenick, Perencivich, Taboada and Barbosa	2006	Use of stimulating tasks to increase situational interest	Motivation and reading comprehension	Motivation mediated the effect of stimulating tasks on reading comprehension on standardized assessments. Situational interest did not generalize to other books.
Isbell, Sobol, Lindauer and Lowrance,	2004	Story telling and story reading.	Oral language complexity and story comprehension	Story reading yielded improved story comprehension and story telling resulted in improved language complexity
Lonigan, Anthony, Bloomfield, Dyer and Samwel	1999	Typical shared reading or dialogic (interactive) book reading.	Oral language, phonological sensitivity	Dialogic reading intervention improved a measure of descriptive use of language, and shared-reading improved measures of listening comprehension and alliteration detection on standardized assessments.
Lonigan and Whitehurst	1998	Dialogic reading in a school condition, home condition and combination of school and home	Oral language	Improved oral language at post-test, with the largest effect for children in conditions involving home reading.
McGee and Johnson	2003	Inference training	Reading comprehension	Improved reading comprehension compared to standard comprehension strategies. Increased enjoyment of reading.

Oakhill and Patel	1991	Imagery training	Reading comprehension	Training in imagery benefited poor comprehenders
O'Connor, Harty, and Fulmer	2005	Three-tiered intervention: professional development for teachers and reading instruction.	Decoding, word recognition, fluency and reading comprehension	Improved decoding, word identification, fluency and reading comprehension standardized assessments for Tier 2 and Tier 3
Tan and Nicholson	1997	Rapid word recognition	Reading speed, accuracy and comprehension	Improved speed and accuracy of trained words as well as improved comprehension and story retell on post-test measures.

Some papers included in this review do not focus specifically on reading comprehension, but rather on reading in general. In these papers, reading comprehension was often described as one of the outcomes of the intervention. As described by Bishop and Snowling's (2004) adaption of The Simple View of Reading model (Figure 1), decoding ability will affect reading comprehension. Therefore, if an intervention improves a child's decoding difficulties, comprehension should improve as a result, because more cognitive resources are freed up for comprehension. There was great variation in the types of intervention examined in the literature – ranging from phonological interventions (Denton et al., 2006; Tan & Nicholson, 1997) to language-based interventions (Clarke et al., 2010; Isbell et al., 2004; Lonigan & Whitehurst, 1998), to behavioral (Guthrie et al., 2006) and metalinguistic interventions (McGee & Johnson, 2003; Oakhill & Patel, 1991). This variety contributes to the richness and diversity of the literature in the field and is suggestive of the multi-component nature of reading and reading comprehension.

All of the studies gave thorough descriptions of the outcomes measures of the intervention. Some of the outcomes were evaluated using standardized assessments (e.g. Clarke et al., 2010; Denton et al., 2006), while other studies used more informal evaluations of outcomes measures (e.g. Oakhill & Patel, 1991). In the latter, a detailed description of the methods and material used to evaluate outcomes was provided. Detailed descriptions of the procedure and outcome measures are necessary for replication, which is an important measure

of experimental control, and can enhance the internal and external validity of a study (Byiers, Reichie & Symons, 2012).

Most of the studies specified the dosage and intensity of the intervention, except for those by Isbell et al (2004) and Lonigan et al (1999), in which exact dosage was not specified. Particular emphasis was placed on intervention dosage in the O'Connor et al study (2005), in which the intensity of the intervention varied depending on the incidence and severity of their reading disorder. The issue of dosage will be discussed in further detail later in the chapter.

1.4.2.4. Interpreting the results: design, control and generalization:

Although the studies varied widely in their design, many included pre and post test measures (Bowyer-Crane et al., 2007; Clarke et al., 2010, Guthrie et al., 2006 Oakhill & Patel, 1991) in order to evaluate the outcomes of the intervention. The study by Denton et al. (2006) employed a rigorous design using multiple baselines as well as pre and post test measures. Randomized control trial designs used by Bowyer-Crane et al. (2007) and Clarke et al. (2010) were other studies that employed a robust research design. All of the other studies opted for less rigorous designs that compared results before and after intervention.

Studies also varied considerably in terms of the control measures used. The two randomized control trials (Bowyer-Crane et al., 2007; Clarke et al., 2010) had the most stringent control measures – a characteristic of this research design. Both studies made use of large sample sizes and long-term follow-ups. Another similarity between some of the studies was the use of matched participants and control groups (e.g. McGee & Johnson, 2003; Oakhill & Patel, 1991; Guthrie et al., 2006). The study by Tan and Nicholson (1997) matched intervention items in terms of content and difficulty. Denton et al. (2006) made use of regular observations of fidelity to ensure that the interventions were implemented consistently with high quality and according to their specifications. The authors also managed to achieve a stable baseline prior to intervention in order to control for the effects of maturation and development. In addition, their long-term follow up showed that the results of intervention were not temporary. In

contrast to these more thorough control measures, the study by Isbell et al (2004) did not make use of any control measures, which resulted in a weaker methodology and design.

In terms of generalization, studies were evaluated by noting whether generalizations were across-item or across-task. Across-item generalization refers to generalization that occurs from treated stimuli to untreated items (Pascoe et al., 2006). The untreated items are similar to those worked on in intervention but these have not been used in therapy and are often from the same modality as the intervention items. Across-task generalization refers to generalization that has extended from the task treated in intervention (e.g. expressive oral vocabulary of a particular set of words) to other related tasks not specifically worked on in therapy (e.g. spelling of those same words) (Pascoe et al., 2006). In this literature, all of the studies showed positive outcomes with across-item generalization, with one (Tan & Nicholson, 1991) being the most successful by achieving both across-item and across-task generalization. Table 5 summarizes the studies by design, controls and generalization.

Table 5. Reading and language interventions for children from preschool to grade 3:
Interventions, outcomes and results.

Author/s	Year	N=	Design	Controls	Generalization
Bowyer-Crane, Snowling, Duff, Fieldsend, Carroll, Miles, Gotz and Hulme	2007	152	Randomized control trial with pre and post test measures	Large sample size Long term follow-up	Across item generalization
Clarke, Snowling, Truelove and Hulme	2010	84	Randomized control trial with pre and post test measures	Large sample size Long term follow-up Control group	Across item generalization
Denton, Fletcher, Anthony and Francis.	2006	27	Multiple baseline design and repeated pre and post therapy measures	Regular observations of fidelity implementation Achieved stable baseline	Across item generalization
Guthrie, Wigfield, Humenick, Perencovich, Taboada and Barbosa	2006	98	Pre and post therapy measures	Demographically matched participants High correlation of measures with standardized tests	Across item generalization
Isbell, Sobol, Lindauer and Lowrance,	2004	38	Pre and post test measures	None	Across item generalization
Lonigan, Anthony, Bloomfield, Dyer and Samwel	1999	95	Pre and post test measures	No-treatment control group	Across item generalization
Lonigan and Whitehurst	1998	91	Pre and post test measures	Random assignment of participants to treatment and control groups Double-blinded teachers to avoid bias	Across item generalization
McGee and Johnson	2003	40	Between subject design	Matched participants Control group	Across item generalization
Oakhill and Patel	1991	44	Pre and post test measures	Matched participants Control group	Across item generalization
O'Connor, Harty, and Fulmer	2005	300	Cohort study Pre and post test measures	Historical control group Long term follow-up	Across item generalization
Tan and Nicholson	1997	42	Randomized block design	No-treatment control group Inter-rater agreement with uninvolved party. Matched items for content and difficulty	Across item generalization Across task generalization (for related language processing task)

1.4.2.4. Summary of reading comprehension intervention studies:

There is a fairly small set of studies that have tested reading comprehension interventions with school-aged children from preschool to grade 3. Some of these were discussed in this section. The studies all demonstrated the efficacy of

intervention with some positive results and outcomes. However, there is a lack of published studies showing unsuccessful outcomes of intervention, which causes a bias in the literature. There were a wide variety of interventions used in these studies. This variety contributes to the development of a rich body of literature that supports various intervention programmes. Areas to be addressed in future research include:

- (1) Discussion and publication of interventions with unsuccessful outcomes
- (2) Inclusion of detailed information on intervention dosage and intensity
- (3) The inclusion of as many control measures as possible in order to evaluate the true outcomes of an intervention and to eliminate and extraneous variables that contributes to the intervention effect
- (4) Inclusion of clear and explicit rationales for supporting theories.
- (5) Inclusion of models of reading comprehension to guide theory and intervention. This point will be considered further in the following chapter.

As points 2 – 5 are accounted for in this current study, this strengthens it's design and methodology.

1.4.3. Dosage and app-based technological interventions for reading comprehension:

Empirical evidence exists for many interventions in SLT, however relatively little is known about the optimal intensity of these interventions (Baker, 2012). In order for SLT to be effective, the therapist needs to know what type, how often and for how long intervention is required for each individual client (Baker, 2012). There are a number of client-, therapist-, condition- and service-related variables that influence this controversial issue of intervention dosage and intensity.

The issue of dosage in SLT intervention is a complex one as many factors influence the frequency and intensity of intervention (Enderby, 2012). For example, parents whose children attend SLT have time pressures and need to consider making practical arrangements (Enderby, 2012). Together with this,

there are also the financial implications of therapy, and this too influences how often and for how long an individual can attend regular sessions. Therapists themselves also have a range of pressures that influence the intensity of service delivery. They need to consider equity of provision and may need to lower levels of intensity for clients with financial restrictions.

Baker (2012) and Enderby (2012) suggested that the therapist should consider *what* skill the intervention is targeting, because simply increasing the dosage may not be a viable way to enhance learning of that specific skill, which is particularly the case for emergent literacy interventions (Schmitt & Justice, 2012). However, as a consequence of the lack of researched and published literature on therapy dosage, many SLTs are unaware of the recommended amounts of therapy provision for particular conditions (Zeng, Law & Lindsay, 2012). In addition, many clients present with more than one difficulty that therapy needs to address. Individuals with dual diagnoses or severe symptoms require longer, more intensive intervention programmes, which often show less desirable results than intervention for a single diagnosis (Enderby, 2012). In a study by Togher (2012) it was recommended that therapists actively seek advice from clients, their families and communication partners about their perceptions of increasing intervention intensity, in order to assist in intervention planning.

Dosage of intervention varies depending on the condition that is being treated (for example, adult acquired aphasia versus a childhood phonological disorder). Basso (2005) reviewed the literature on frequency and duration of therapy in studies on acquired aphasia in adults. This study showed that the number of therapy sessions was important and that protracted therapy over months and years had significantly positive outcomes on the functional language and communication of these clients.

In terms of childhood speech and language disorders, a review by Zeng et al. (2012) evaluated the relationship between dosage, intensity and effect size in 20 randomized control trials of intervention for vocabulary, syntax and phonological interventions. Their study confirmed that specific dosage was

often not included in many of the articles they reviewed. In those studies that specified dosage, it was found that session length and the number of sessions required was lower for phonological interventions, as opposed to vocabulary interventions. However, they too reported that dosage was not necessarily correlated with successful outcomes of intervention – many other issues related to the client, therapist and service came into play (see Baker, 2012 and Enderby, 2012). This finding was confirmed by Schmitt and Justice (2012), who reviewed intervention articles on emergent literacy. Studies that specifically addressed intensity of intervention for phonological awareness and print knowledge also showed that increasing the intensity of these interventions did not always yield more positive results.

There is very little research in the literature investigating dosage for reading comprehension interventions. Schmitt and Justice (2012) and Zeng et al. (2012) recommended that more information and research is needed about the effect of dosage on intervention outcomes for therapists to make informed recommendations about *optimal* dosage. Future research should focus on more large-scale systematic studies on optimal dosage of intervention for various speech, language and communicative conditions in both the paediatric and adult populations.

Enderby (2012) and Togher (2012) highlighted the significant potential of technological intervention programmes to facilitate the intensity at which intervention is delivered. With advances in new technologies, the development of tablets has influenced service delivery models of SLT (Togher, 2012). However, despite anecdotal reports from therapists, parents and clients alike, there are relatively few empirical studies focusing on the use of technology for intervention, with even fewer evaluating tablet application (app) based interventions. The benefits of the tablet form have been documented in the literature and have been described as a hands-on, interactive, motivating and engaging vehicle for children's learning, with intuitive usability (Bush & Hall, 2012; Hynan, Murray & Goldbart, 2014; Roschelle et al, 2007; Vance & Clegg, 2014). The best outcomes are generated when the use of tablets/technology are

supported and mediated by other individuals (Vance & Clegg, 2014). In addition, the tablet provides an opportunity for increasing dosage and independence for learning (Wolf, Ullman-Shade, Gottwald, 2012), which is particularly relevant in developing countries where teachers and health professionals are overburdened and understaffed. In the classroom, technology is being used more and more by both teachers and learners (King, Thomeczek, Voreis & Scott, 2014). Tablets specifically may allow the teacher to create tailor made programs for each learner and monitor their progress more accurately, which is often impossible given the large number of learners in a classroom (Wolf et al., 2012). In a study by King et al. (2014), it was reported that tablets have the opportunity to increase academic engagement in young children and adolescents, particularly those with developmental disorders, such as Autism Spectrum Disorder.

A single subject design study by Knollman-Porter, Dietz and Lundeen (2011) showed that an intensive intervention with an auditory comprehension app was effective for improving auditory comprehension of single words in adults with chronic severe aphasia. The app used in the study followed therapeutic principles, used linguistically structured items and addressed both input and output processing. This is a positive preface for further exploring the potential value of app-based intervention with children in the South African population. This study aims to contribute to the literature on app-based intervention for children with reading comprehension difficulties and the efficacy of this intervention in the South African context.

1.5. SUMMARY OF CHAPTER:

This chapter began by considering literacy in the South African context, and discussed education in the context of the country's history of colonialism and apartheid. This history contributed to the current state of education in post apartheid South Africa and the inequalities in the education system that persist today, despite the political reform. The role of SLTs in education was then considered by examining the connection between language, literacy and learning. SLTs need to make this connection between language and literacy visible and align themselves with the needs and outcomes of general education.

SLTs need to play a collaborative role in order to achieve this. The next section of this chapter examined the link between language and literacy more closely and described the various component skills needed for reading comprehension, including phonological awareness and word recognition skills. Finally, the literature on reading comprehension intervention studies was reviewed by examining various areas of these studies, including: subject characteristics, intervention outcomes and results, supporting theories as well as research design, control and generalizations. This chapter concluded with a look at the controversial topic of intervention dosage and how app-based tablet interventions can increase the intensity of intervention, and considered some of the other benefits of this medium in light of the South African context.

The following chapter will focus on the two different approaches of theoretical models of reading comprehension – that is, longitudinal developmental models of reading as well as psycholinguistic frameworks of real-time processing in reading comprehension.

CHAPTER TWO: THEORETICAL FRAMEWORKS FOR UNDERSTANDING READING

2.1. INTRODUCTION TO CHAPTER:

Theoretical models or frameworks attempt to define and map out complex phenomena such as reading. They offer an attempt to understand the typical occurrence of such phenomena and may also be used to explain the difficulties that can occur in some cases. Their accuracy and value can be tested out in research studies or clinical practice, and in this way they are often developed further or modified.

There are two main types of theoretical models used to understand reading. Models of development are longitudinal in nature and outline the progression from one developmental phase to the next. Examples of developmental models of reading and reading comprehension include those by Frith (1985), Stackhouse and Wells (1997), and Chall (1996), which will be discussed in further detail in the body of this chapter. The second group comprises information processing models that track real-time cognitive and linguistic processing during the moment of reading. These include single route and dual route information processing models, with the emphasis of this section being on the dual route model by Ellis and Young (2002). This chapter will describe key developmental and information-processing models for reading that are of relevance to this study and consideration will be given to how these models influence clinical practice.

2.2. DEVELOPMENTAL MODELS OF READING:

Longitudinal models of development are used to depict stages or phases of development and developmental trajectories of skills over time. They are useful as they allow for a better understanding of how a child develops a particular skill as well as specifying the exact stage at which the child is struggling to progress (Beech, 2005; Ehri & McCormick, 1998; Frith, 1985; Pascoe et al., 2006). There are a number of stage and phase models used in the literature on reading development and all of them include similar principles of alphabetic knowledge,

phonological awareness, decoding, word recognition and comprehension (Chall, 1996; Ehri, 2005; Frith, 1985; Gustafson, 2000). In comparison to information-processing models, developmental models generally consider the 'bigger picture' of language and literacy development and assist clinically, in assessment and intervention planning (Beech, 2005; Ehri & McCormick, 1998). In this next section, developmental models of word recognition and decoding will be discussed first; followed by models that link literacy development with speech and language.

2.2.1. Developmental models of word recognition and decoding:

There are a number of stage and phase models of word recognition and decoding, all of which describe a gradual shift from phonological to orthographic word decoding (Ehri, 1995; Frith, 1985; Gustafson, 2000; Høien & Lundberg, 1988). Ehri (2005) distinguished between the use of terms 'stage' and 'phase' when referring to developmental models. She chose to use the term 'phase' in order to avoid the more rigid criteria that are usually associated with stage theory (Beech, 2005; Ehri & McCormick, 1998). According to Ehri (2005), phase theory provides a less stringent, more fluid view of the course of development than stage theory. This is better suited for considering the progression of development, because individual typically-developing children each have a unique course and speed of development (Beech, 2005; Ehri & McCormick, 1998). In this chapter, Frith's (1985) stage model will be discussed first, as this was one of the earliest and most prominent models that influenced other developmental models of reading, such as those by Ehri (1995) and Høien and Lundberg (1988).

Frith's developmental stage model of reading was published in 1985 and was developed to better understand the theoretical assumptions and principles underlying developmental dyslexia (Frith, 1985). She stated that the purpose of developmental models of reading was to explain how skilled, typically developing readers mastered the various strategies of reading, moving through a sequence of steps, mediated by environmental and constitutional factors (Frith,

1985). The model conceptualizes three stages of typical literacy acquisition: a logographic or whole word recognition stage, an alphabetic stage in which grapheme-phoneme knowledge is developed, and an orthographic stage in which stored representations can be accessed and irregular orthography (spelling) is learnt (Frith, 1985; Pascoe et al., 2014). Figure 2 outlines the three stages:

1. Logographic stage: This is a visual phase in which children immediately recognize whole, familiar words (whole word recognition) and are unable to decode unfamiliar words. These familiar words may include their name or high frequency signs (e.g. 'STOP' signs on the road). In terms of spelling, children in this phase may be able to write their name, but have no knowledge of letter-sound correspondence. Therefore, they are unable to spell phonetically and spelling consists of a random assignment of letters.
2. Alphabetic stage: This refers to the knowledge and use of individual sounds and letters and their correspondence. In this phase children use letter-sound correspondence rules to decode new and nonsense words by segmenting (sounding out) individual letters and blending them together to form a word. In spelling, children begin to show some logical letter-sound correspondence, but also tend to omit some vowels and use single letters to represent syllables. As the child progresses through this stage, spelling becomes more phonetic and logical and their words are often recognizable, even if they are not spelt entirely accurately.
3. Orthographic stage: Here, the child rapidly analyzes words into orthographic components, without relying on letter-sound rules, and learns the rules of English orthography. They are able to recognize parts of words quickly, such as prefixes and suffixes, which allows them to read words by analogy and makes them more efficient readers. This phase is distinguished from the logographic phase by the systematic analysis of smaller letter units, as opposed to pure visual recognition of whole words. It is also distinguished from the alphabetic phase in that larger units/letter combinations are recognized and decoding is non-phonological.

4. If all of the above mentioned stages are followed, the child literacy development is considered to be normal.

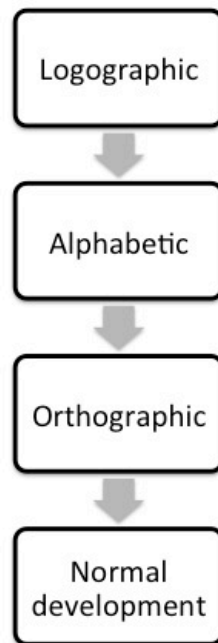


Figure 2: Frith's (1985) three-stage model of reading development.

Frith's theory and model has generated a large amount of research in the field of reading, and has been cited and supported in work by Coltheart (2006a); Gallagher, Frith and Snowling (2000); Nation and Snowling (2004); Pascoe et al., (2006); Rack, Snowling and Olson (1992) and Roman, Kirby, Parrila, Wade-Woolley and Deacon (2009). For example, Gallagher et al. (2000), who investigated the precursors of literacy delays in children with a genetic risk factor for dyslexia used Frith's phase model to plot the participants' level of reading development and made reference to it in the interpretation of the study's findings. In a review by Rack et al. (1992) on nonword reading difficulties in developmental dyslexia, Frith's model was used to explain developmental issues of dyslexia. These authors made reference to her hypothesis that dyslexia was caused by arrested development at the logographic phase. Pascoe et al (2006) supported the use of Frith's model in assessment and intervention of both

speech and literacy development and used this model to demonstrate the link between speech and literacy development. The link between speech and literacy development will be described in further detail later in the chapter.

Frith's theory aims to provide a framework for how children's reading improves as they mature. It does not account for variations in development, such as quick spurts, decreases, gradual changes or plateaux, which can only be determined through empirical investigations of each individual child (Frith, 1985). Frith also acknowledged that her model did not account for maturational and educational factors that trigger change and development. Instead, she hypothesized that beginning readers transition from one stage to the next by merging old and new strategies. During this process, some old components remain in order to support the development of a new strategy.

Another limitation of Frith's model is that it does not provide sufficient detail in describing the processes in the alphabetic stage. The alphabetic stage is more thoroughly addressed in a phase model by Ehri (1995). In her model, Ehri (1995) considered learning of alphabetic principles to be the most important and separated this into two phases (partial and full alphabetic) to adequately account for the complexity of alphabetic learning. Compared to Frith's model, Ehri (1995) defined the alphabetic processes more specifically and provided detailed description of the component skills that are characteristic of this phase, such as phonological awareness, phonological coding and sight word learning. Another advantage of Ehri's framework was her explicit choice of the term 'phase' rather than 'stage' in describing progression from one level to the next. The term 'phase' implies that the progression from one level to the next cannot always be clearly defined.

In summary, Frith's stage model was a seminal piece in the literature on reading development models and has since been well established and widely cited in research and clinical literature on reading, spelling and speech processing. It is limited in some ways, e.g. it provides a limited description of the alphabetic phase, one of the most important processes of reading development (Beech,

2005; Ehri, 1995; Ehri & McCormick, 1998). The complexities of this alphabetic stage are better represented in Ehri's (1995) phase model of reading development, which will be discussed in the following section.

Ehri (1995) drew heavily on Frith's theoretical assumptions and subsequently generated a model of reading development with similar principles of phonological to orthographic word decoding. Ehri outlined four phases of development, these being the pre-alphabetic, partial alphabetic, full alphabetic and consolidated alphabetic phases (Ehri, 1995; Ehri, 2005; Ehri & McCormick, 1998; Nation & Snowling, 1998). The pre-alphabetic phase is characterized by whole word recognition with no knowledge of letter-sound correspondence rules, much like Frith's logographic phase. The partial alphabetic phase refers to how children learn some letter-sound correspondences, but not all. For example, at this stage they may be able to identify the initial and final sounds in words, as these sounds are often easier to detect. They are unable to segment all the phonemes in words and lack full knowledge of the alphabetic system and struggle with vowels in particular. Sight word learning and a complete knowledge of the alphabetic system characterize the full alphabetic stage. During this phase phonemic awareness is also acquired and children learn to decode words using their working knowledge of alphabetic principles. This results in children sounding out many of the words they read, making reading slower and more laborious.

The partial and full alphabetic phases combined can be likened to Frith's alphabetic phase and together adequately describe the processes of phonological awareness, phonological coding and sight word learning. Finally, the consolidated alphabetical reader is able to retain a greater inventory of sight words in memory and is familiar with letter combinations, similar to Frith's orthographic phase. The consolidated alphabetic phase usually occurs in grade two and begins during the full alphabetic phase. It is also characterized by learning letter chunks (e.g. affixes, onset, rimes, root words), which improves speed and accuracy of reading. Children in this phase learn to read words by

analogy with known words (detecting common spelling patterns) and decoding strategies are expanded to deal with unfamiliar and multisyllabic words.

Ehri's model has been cited and supported in research by Ehri (2005); Ehri (2013); Ehri and McCormick (1998); Nation and Snowling (1998); Rack et al. (1992). In the paper by Ehri and McCormick (1998), the four phases of Ehri's model were outlined and their application for teachers working with children with reading problems was explained. In a later paper by Ehri (2005), the developmental model was used to explain how typically developing children read words by sight. Ehri's reading development model was also referred to in the paper by Nation and Snowling (1998), in which the semantic processing and word recognition skills in children with reading problems were investigated.

Beech (2005) wrote a paper critiquing Ehri's model and pointing out some weaknesses of the model. These included poor operational definitions, limited detailing of the development of underlying cognitive structures and a final phase that did not sufficiently account for mature reading. However Beech (2005) concluded that despite these problems, Ehri's model provides a useful and flexible framework to understand reading development. In summary, Ehri's model provides a more thorough account of reading (particularly in the alphabetic stages), and despite some limitations her model provides a useful and clinically relevant framework for understanding reading development.

As difficulties with decoding are some of the main causes of reading problems in children (Gustafson, 2000; Oakhill et al., 2003; Nation et al., 2007; Snowling & Hulme, 2011), these developmental models are of significant value in understanding the typical progression of reading development. They also have a clinical application for assessment and intervention planning - in order to identify difficulties and plan intervention for those children with disordered reading, the clinician first needs to have a clear understanding of typical reading development (Beech, 2005; Ehri & McCormick, 1998; Pascoe et al., 2006).

A limitation of the models described in this section is that they cannot be universally applied to all languages, as they focus on the English orthography. English orthography differs from many other orthographies because it is not largely phonetic in nature - that is, many words cannot be read simply by grapheme-phoneme conversion. Therefore, the task of learning to read is different in languages with non-alphabetic scripts with low levels of grapheme-phoneme consistency, compared to languages with more typical orthographies (Cheung, Chen, Lai, Wong & Hills, 2001; Goswami, 2000; Read, Zhang, Nie & Ding, 1986; Wimmer, Landerl & Frith, 1999).

Although the longitudinal phases of reading development are vitally important for decoding and word recognition, the purpose of reading is to understand written language and to use these skills to access further learning and knowledge. The ways in which decoding and oral language interact have been discussed in the previous chapter. Bishop and Snowling's (2004) adaptation of The Simple View of Reading model (Figure 1) is particularly useful for understanding the relationship between decoding and oral language to describe different types of reader profiles. Developmental models of reading that consider the oral language component in reading comprehension are of particular relevance to this study and will be discussed next.

2.2.2 Developmental models that link literacy with oral language:

Bishop and Snowling (2004) adapted Hoover and Gough's influential model of reading called the Simple View of Reading (see Figure 1). This model was based on the premise that oral language and written language are mutually exclusive (Catts, Bridges, Little & Tomlin, 2008; Nation, Cocksey, Taylor & Bishop, 2010; Nation, Snowling & Clarke, 2007; Snowling & Hulme, 2010) and demonstrated the relationship between phonological skills and non-phonological language skills. The Simple View of Reading, introduced in chapter one, describes different reader profiles, e.g. a child who has reading comprehension difficulties may have a problem with decoding, language comprehension, or both (Bishop & Snowling, 2004; Hoover & Gough, 1990). In this section, two developmental

models of reading that explicitly include the role of oral language will be discussed.

The first model of this kind was developed by Stackhouse and Wells (1997), in which the relationship between speech and literacy development was demonstrated. Here, the term 'speech' refers to the speech processing system, which is a system that enables a child to develop and make sense of oral language (Pascoe et al., 2006). Stackhouse and Wells (1997, 2002) stated that speech, phonological awareness and literacy have a mutually supportive relationship. The speech processing system forms the basis of the development of these skills. This notion has been supported in the literature by a number of researchers, including Gillon (2002, 2004); Moriarty and Gillon (2006); Pascoe, Stackhouse and Wells (2004); Pascoe et al. (2014) and Sutherland and Gillon (2007). Figure 3 summarizes the relationship between speech, phonological awareness, literacy and the speech processing system.

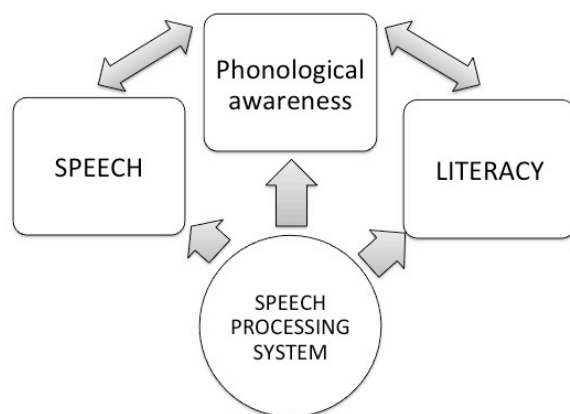


Figure 3: The relationship between speech, phonological awareness and literacy (adapted from Stackhouse & Wells, 1997).

Stackhouse and Wells (1997) devised a model that showed the relationship between the phases of speech development and the phases of reading development. They used Frith's (1985) model of reading development to depict their theory. This is shown in Figure 4.

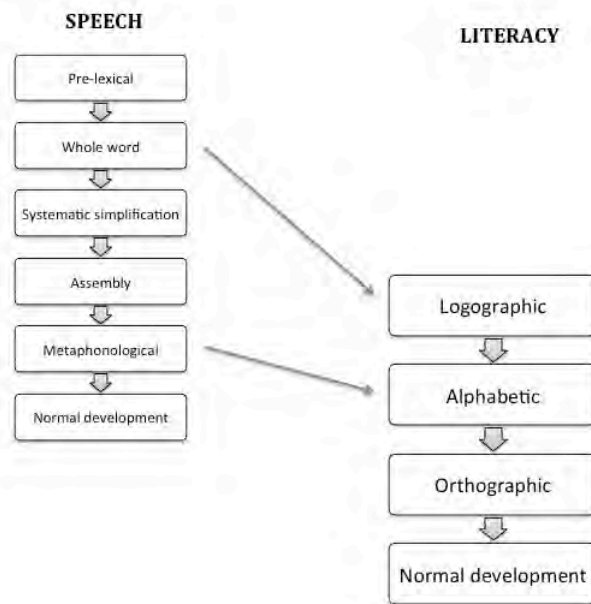


Figure 4: The relationship between the phases of speech and literacy development (adapted from Stackhouse & Wells, 1997).

Stackhouse and Wells proposed that children who move smoothly through the phases of speech development would have the necessary phonological awareness skills to support their literacy development. If the child passes through each of these phases of development, their speech and literacy development is considered to be normal. Difficulties with any of the phases of speech development, or difficulties moving from one phase to the next, will result in both speech and literacy difficulties (Stackhouse and Wells, 1997, 2002). The phase in which the child has difficulties, or is arrested, will determine the nature of the associated speech and literacy difficulties. Of particular relevance to literacy development are the whole word and metaphonological phases of speech development, where children develop a parallel phase of logographic and alphabetic knowledge respectively. Children who are arrested at the whole-word phase, whose speech is characterized by inconsistencies and atypical features, will have trouble developing phonological awareness and associated literacy difficulties (Pascoe et al., 2006; Pascoe et al., 2014). Children also need to enter the systematic simplification phase for them

to develop phonological awareness and associated literacy skills typical of the later metaphonological phase.

This developmental model that demonstrates the connection between a speech processing system, literacy and phonological awareness is an example of a phase model that takes into account the influence of oral language (i.e. speech processing system) on written language (i.e. literacy). Stackhouse and Wells' theory is supported in the literature by Carroll and Snowling (2004); Fawcett and Nicolson (2002); Goswami (2000); Snowling and Stackhouse (2006) and Strattman and Hodson (2005). In the paper by Goswami (2000), in which theoretical frameworks for understanding reading were discussed, Stackhouse and Wells' model made significant contributions to the discussion of an integrated cross-linguistic theoretical framework for conceptualizing reading. Carroll and Snowling (2004) investigated the influence of phonological processing on dyslexia and used the Stackhouse and Wells model to describe the parallels between speech and literacy development. Strattman and Hodson (2005) wrote about the variables that influence decoding and spelling in beginning readers, such as phonological awareness, working memory, rapid naming and expressive phonological productions. In their discussion, these authors made reference to Stackhouse and Wells' model, particularly when describing the influence of expressive phonological productions and phonological awareness on literacy. The next paragraph will discuss Chall's (1967; 1996) model, which is another model of reading development that also explicitly takes into account the role of oral language in reading.

Chall (1967, 1996) proposed a six stage model of reading development demonstrating the manner in which readers acquire skills, from pre-reading emergent literacy, to decoding skills and comprehension of complex texts (Paris & Hamilton, 2010). In the first stage of Chall's model (1967, 1996) the reader acquires pre-reading skills such as concepts of print, phonemic awareness, letter knowledge and book-handling skills. These are considered to be emergent literacy skills, which are defined as the prerequisite knowledge for reading and writing, acquired during the preschool years prior to formal literacy instruction

(Justice, Chow, Capellini, Flanigan & Colton, 2003; Justice & Ezell, 2004; Justice & Pullen, 2003). The acquisition of these emergent literacy skills is heavily influenced by the cultural and social conditions in which the child is reared (Justice & Pullen, 2003). For example, if a child is not frequently exposed to language, books and literacy stimulation, he/she will be at risk for difficulties in the development of emergent literacy (Justice & Pullen, 2003).

The second stage of Chall's model, usually starts when a child is in grades one and two. This is when conventional reading begins with the learning of decoding, such as letter-sound knowledge and word recognition. In the third stage of Chall's model, which is usually around grades two to three, the reader becomes more efficient as decoding skills are consolidated, sight word lexicon increases and reading fluency improves. The fourth stage occurs between grades four and eight and is marked by a distinct "shift from 'learning to read' to 'reading to learn'" (Paris & Hamilton, 2010, p. 37). This shift also happens in the classroom, with a change from narrative stories to expository texts that reflect the content and subject matter in the classroom. The fifth and sixth stages are characterized by reading comprehension of more complex, higher-level texts. In stage five children can read about varying views on the same subject matter, but are only able to integrate these views by stage six. Figure 5 depicts these stages.

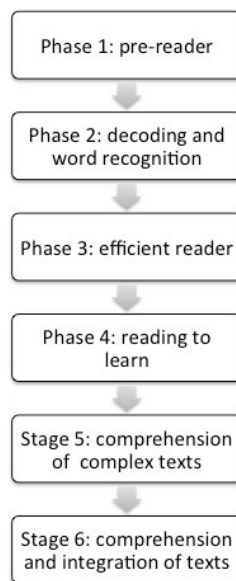


Figure 5: Chall's (1967, 1996) six-phase model of reading development.

Chall's work on reading development models has been cited and supported by a number of researchers including Fitzgerald and Shanahan (2000); Kame'enui and Simmons (2001); McCoach, O'Connell, Reis and Levitt (2006); Paris and Hamilton (2010) and Spear-Swerling and Sternberg (1994). Spear-Swerling and Sternberg (1994) described an integrated model of reading disability and stated that their view of typical reading acquisition was influenced heavily by Chall's model; however their model focused more on cognitive skills, as opposed to academic skills in Chall's model. Another model proposed by Fitzgerald and Shanahan (2000), suggested critical markers of the stages of reading and writing development. These authors also drew heavily on Chall's model for explaining the reading component of their model.

Although Chall's model provides a less detailed account of decoding, it gives insight into the sequential development of reading comprehension and meta-linguistic skills. In this way, this model is useful in clinical assessment and intervention planning for children with reading comprehension difficulties. Combined with Ehri's model of decoding, this model provides a detailed description of reading that can be applied to clinical practice. Considering the roles of language comprehension and decoding allows for a comprehensive

understanding of a child's reading development as a whole. For this reason, both Ehri's and Chall's models will be used for analysis and discussion in this study.

Phase and stage models are often criticized because they follow a linear and structured approach which may not provide a realistic representation of how all children develop – that is, not all children develop reading via the prescribed, expected sequence (Beech, 2005; Ehri & McCormick, 1998; Paris & Hamilton, 2010). Stage models have also been accused of not accurately representing the complexity of development and knowledge at each phase (Beech, 2005; Ehri, 1995; Ehri, 2005). For these models to be useful and functional, they need to include the developmental trajectories of each particular skill involved in reading, because different component skills influence different stages of reading development (Nation & Snowling, 2004; Oakhill et al., 2003; Paris & Hamilton, 2010; Snowling & Hulme, 2011). That is, the development of decoding skills in typically developing children usually reaches a ceiling around 8 – 9 years of age (Paris & Hamilton, 2010). However in contrast, language comprehension skills have a longer trajectory of development, as they develop from infancy throughout adulthood (Owens, 2002; Paris & Hamilton, 2010; Roth & Worthington, 2010). Therefore, although stage models are helpful in better understanding and assisting reading development, it is important to consider the unique history and progression of each individual child's reading development (Paris & Hamilton, 2010).

This concludes the discussion on longitudinal developmental models of reading. The following section will discuss information processing models that depict real-time processing during the act of reading.

2.3 INFORMATION PROCESSING MODELS FOR READING:

Developmental phase models are important because they provide a broad picture of typical reading development. However, another type of reading model is needed to understand what happens during real-time reading. Information processing models describe these real-time cognitive and linguistic processes and explain how written words are recognized, understood and read aloud (Ellis

& Young, 2002; Harley, 2001; Paris & Hamilton, 2010). Theorists have taken two different stances, depending on their underlying philosophy of the process of reading. One stance supports a revised dual route model of reading while the other supports a single route (Coltheart, 2006a; Harley, 2001; Plaut, 2004). An information processing model of reading needs to be able to account for how we read regular (e.g. beef, hint), exception (e.g. streak, have) and nonwords/unfamiliar words that we have never seen before (e.g. fot, datch, smeak) (Ellis & Young, 2002; Harley, 2001; Paris & Hamilton, 2010). It must also account for grapheme-phoneme conversion, as this is a necessary skill for children who are learning to read alphabetic languages. Finally, it should account for how different types of reading disorders present.

In this section, both dual route and single route reading models will be discussed. A dual route model by Ellis and Young (1988, 2002) will be discussed in greater detail as this model fits well with the psycholinguistic perspective of the study because it considers aspects of how speech and language interact with the reading process.

2.3.1. Single route information processing models of reading:

Single route information processing models describe a single procedure for reading aloud, by converting print to speech. There are two types of models that fit into this category, namely analogy models and connectionist models, both of which will be discussed here.

Analogy models originated in the late 1970s when the phenomenon of how we read unfamiliar/nonwords became of interest (Harley, 2001). Analogy models are single route models that propose that both real words and nonwords are read via a single mechanism, by analogy with other known words (Goswami, 1993; Zorzi, Houghton & Butterworth, 1998). When a word is identified, it activates words that are similar and thus determines how the word is pronounced (e.g. “sing” activates “ring”, “wing”, “thing” etc.). However, analogy models received many criticisms due to insufficient explanations for how we

pronounce some nonwords by analogy and unclear explanations of how the input is broken down into segments/parts for analogy (Harley, 2001). With this said, analogy models were influential in the development of later connectionist theories.

Connectionist models are also based on the single route theory for reading and propose that the reader recognizes letter strings as words and then pronounces them. The Seidenberg and McClelland model of 1989 (also known as the “triangle model”) is the most influential of such models and proposes that both reading and speech use three ‘codes’: orthography, meaning and phonology. This computational model uses systems to map letters to sounds by replicating a neural network that reads regular, exception and nonwords using a single route from print to speech (reading aloud) (Coltheart, 2006a; Nation & Snowling, 1998; Norris, 2004; Plaut, 2004). This model was criticized for showing poor reading of nonwords and it was unable to account for surface dyslexia (defined as a difficulty reading words with irregular spelling) (Zorzi et al., 1998).

Although neither of these models provides an entirely complete and accurate account of reading, they have made significant contributions to our understanding of it. The majority of the literature on information processing models for reading is in support of dual route models, as these appear to provide a more comprehensive account of real-time processing. This next section will discuss dual route models in greater detail, and focus particularly on the model by Ellis and Young (1988, 2002).

2.3.2. Dual route information processing models of reading:

Our ability to read irregular and nonwords suggests the possibility of a dual route model of naming and reading of unfamiliar words and nonwords. Dual route models are the simplest versions of multi-route or parallel coding models, which outline two or more reading routes – one route for the reading of familiar words, another for reading exception words and another for reading nonwords (Castles, 2006; Coltheart, Rastle, Perry, Langdon and Ziegler, 2001; Harley, 2001;

Norris, 1994).

In response to Seidenberg and McClelland's (1989) single route computational connectionist model, Coltheart and colleagues (Coltheart, Curtis, Atkins & Haller, 1993; Coltheart et al., 2001; Coltheart & Rastle, 1994; Rastle & Coltheart, 1999; Ziegler, Perry & Coltheart, 2000, 2003) developed a dual route computational model of reading (Perry, Ziegler & Zorzi, 2007). This model is known as the Dual Route Cascade (DRC) model and was found to be the most successful of the computational models of reading (Coltheart, 2006a; Coltheart et al., 2001; Perry et al., 2007). The DRC model implements lexical and non-lexical routes for reading and is the only model that can perform the two tasks most commonly used to understand reading: lexical decision and reading aloud (Coltheart et al., 2001).

In another paper by Coltheart (2006a) the concept and modeling of dual route theory was described. As the same underlying principles apply, Coltheart's (2006a) explanation of dual route models can also be applied to understanding the theory behind the DRC model. Coltheart (2006a) described three separate lexicons that store information about words (see Figure 6). The orthographic lexicon contains stored knowledge about the visual, written forms of words (i.e. spelling); the semantic lexicon contains information about the meaning of words; and the phonological lexicon stores knowledge about the pronunciation of words (Coltheart, 2006a). In this model, Coltheart explained that regular words can be read via either the lexical or non-lexical routes; whereas irregular/exception words can only be read via the lexical route, as the non-lexical route will result in incorrect pronunciation (e.g. 'said' would be pronounced as 'maid'). Nonwords are pronounced via the non-lexical route, where grapheme-phoneme correspondence rules and spelling rules are applied (Coltheart, 2006a).

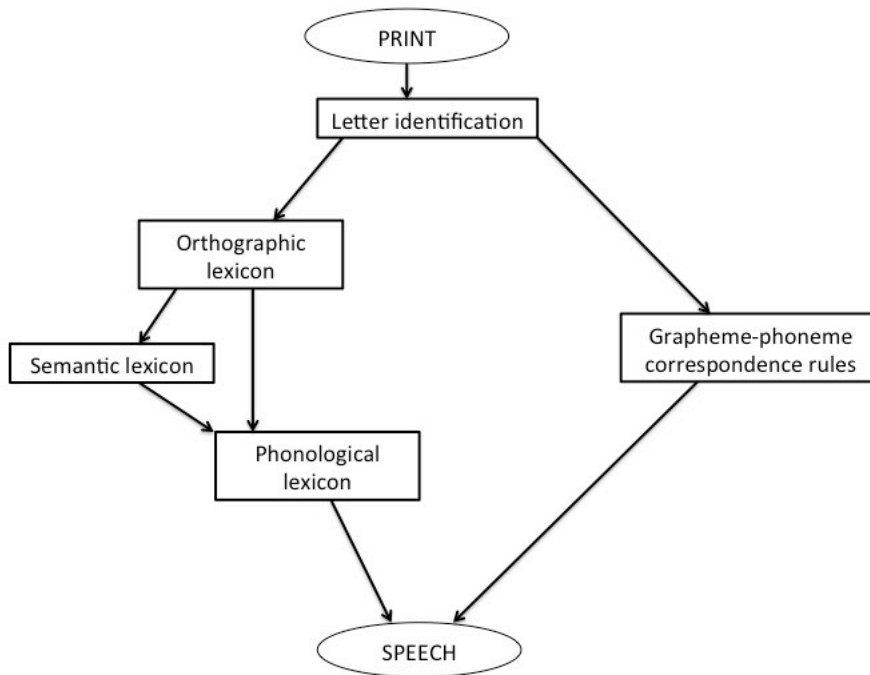


Figure 6: Coltheart's (2006a) elaboration of a dual route model of reading aloud.

The work by Coltheart and colleagues (Coltheart et al., 1993; Coltheart et al., 2001; Coltheart & Rastle, 1994; Perry et al., 2007; Rastle & Coltheart, 1999; Ziegler, Perry & Coltheart, 2000, 2003) is useful for explaining and understanding the concept of dual route models, and the DRC computational model provides impressive evidence for dual route processing in reading. The following section will describe the dual route information-processing model of Ellis and Young (1988, 2002). Ellis and Young's model is one of the most comprehensive models of this kind as it provides detailed, accurate and logical explanations for reading at every level of processing.

2.3.3. Ellis and Young's information processing model:

The dual route information processing model described by Ellis and Young (1988, 2002) appears to be the most comprehensive and functional model for the "recognition, comprehension and naming of written words in reading" (see Figure 7); and has been referenced extensively in the literature on reading (see Cipolotti & Butterworth, 1995; Coltheart, 2006b; Coltheart, et al., 2001; Ellis and Young, 2013; Hulme & Snowling, 1992; Raymer, Thompson, Jason & Le Grand,

1993). The connection between oral language and written language is an integral part of this model as it depicts both the processing of spoken words and written words as well as the interaction between these two processes. As written language is built on the scaffolds of oral language structures, the processing of the latter is important to consider and understand. Therefore, the top left section of the model will be discussed first, as it is concerned with oral language and the recognition of spoken words. This will be followed by a detailed description of how written words are recognized and how the oral and written processes are integrated.

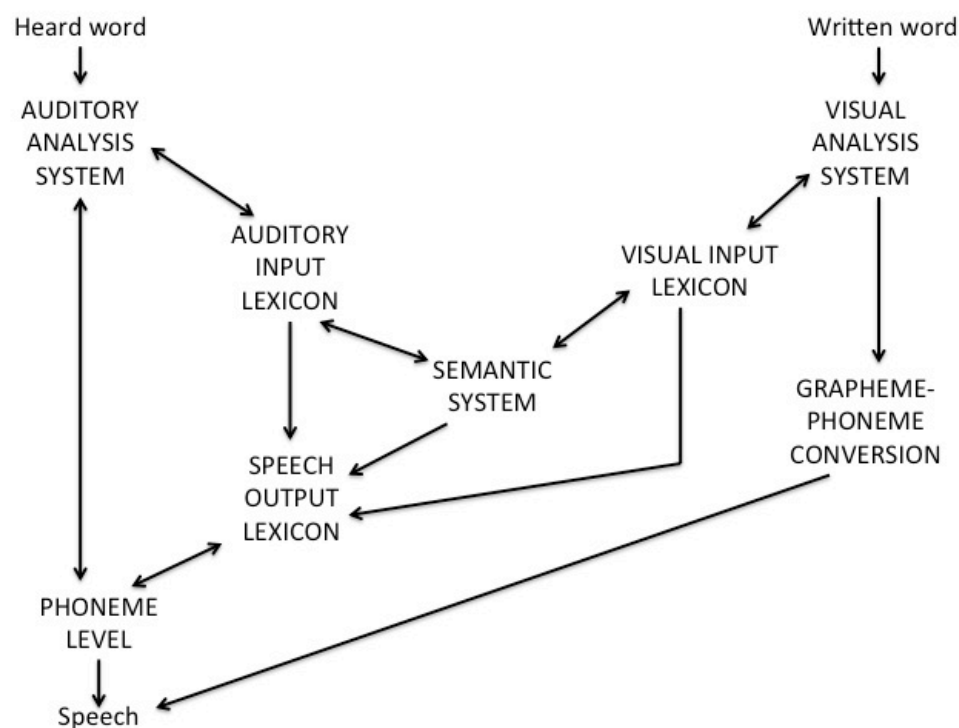


Figure 7: Functional model for the recognition, comprehension and naming of written words in reading (Ellis & Young, 2002).

2.3.3.1. Processing of spoken words:

As depicted in Figure 7, the auditory input lexicon contains an inventory of spoken words that the child has heard before and that are familiar to him or her. Prior to this, the auditory analysis system transforms the acoustic sound waves

that the child hears into a representation that can be recognized by the auditory input lexicon (Ellis & Young, 1988, 2002, 2013). The meanings of words are then housed in the semantic system. A spoken word is only understood when the auditory input lexicon sends a signal to and activates the semantic representation of that word in the semantic system (Ellis & Young, 1988, 2002, 2013). The lower part of the model accounts for the speech production, or output. The speech output lexicon is a memory store for the pronunciation of known words appropriate to the meanings of words produced. This contains all the representations of familiar spoken words and is activated when a word is spoken, for example in connected speech or verbal naming. The representations in the speech output lexicon are also triggered when that word is recognized in the semantic system. This then activates the production of speech sounds at the phoneme level, which results in an output of spoken words. However, words are not always spoken aloud - they are often read silently using 'inner speech'. This process is captured by the two-way arrow between the auditory analysis system and the phonemic level. The connection between these two systems allows the reader to hear himself/herself read or speak without actually saying anything aloud (Ellis & Young, 1988, 2002, 2013).

The connection between the auditory analysis system and phoneme level has another role in repeating aloud nonwords or unfamiliar words. For example, if these nonwords have never been spoken or heard before, they cannot be part of the auditory input or speech output lexicon. However, these nonwords are still able to be said aloud because the auditory input and speech output lexicons are by-passed, so that the input can reach the phoneme level directly and thus be spoken aloud.

2.3.3.2. Processing of written words:

With the foundation for written language being discussed above, the top right part of the model can be introduced. The right hand side of the model is concerned with written language, and the role of the visual analysis system is to visually recognize the components of the written word (that is, the structure and position of the graphemes within the word) (Ellis & Young, 1988, 2002, 2013).

This should not be confused with the process of naming the graphemes – this is purely visual in nature (e.g. what the eye sees). The visual input lexicon then receives this input from the visual analysis system, which houses all the representations of familiar, known written words (Ellis & Young, 1988, 2002, 2013). This is how experienced readers are able to read familiar words automatically, ‘by sight’ (Ellis & Young, 1988, 2002, 2013). The visual input lexicon system then activates the word meaning that is stored in the semantic system. This then activates the speech output mechanism, enabling speech production and resulting in the word being read aloud. This pathway describes the typical route for reading aloud, however there is a second pathway that is necessary for the reading of unfamiliar words (Ellis & Young, 1988, 2002, 2013). If a word has never been seen before, it cannot have an entry in the visual input lexicon. In this case, the new word is identified by the visual analysis system and then the letters (graphemes) are converted into sounds (phonemes) in the grapheme-phoneme conversion system (Ellis & Young, 1988, 2002, 2013). These phonemes are then blended into a pronounceable spoken word (speech output).

Experienced readers rely very little on their grapheme-phoneme conversion skills as most words that they encounter have entries in their visual input lexicon (Ellis & Young, 1988, 2002, 2013). However, beginning readers rely more heavily on grapheme-phoneme conversion in order to sound out the words. In the case of beginning readers, the spoken version of the word that they are reading has usually been heard before and therefore the reader is often familiar with the meaning of the word. Reading the unfamiliar word aloud or reading it silently to oneself activates both auditory (in the auditory input lexicon) and visual pathways (Ellis & Young, 1988, 2002, 2013).

A limitation of this model is that it only considers reading at the single word level, not the phrase, sentence and connected texts levels. However, it still provides a logical and functional structure to better understand the cognitive processes involved in reading which can be applied to reading different levels of text. Another limitation of many of the information-processing models

discussed above, is that there is not much emphasis placed on the processes involved in comprehension, which is treated as an automatic consequence of decoding words quickly and accurately (Coltheart, 2006a; Ellis & Young, 2002; Harley, 2001; Paris & Hamilton, 2010; Plaut, 2004). As these models are in relatively early stages of development, all the authors have acknowledged that more research is needed to refine the models. Despite some of the limitations of information processing models, it is clear that the dual route models, particularly those by Ellis and Young (1988, 2002), provide the most comprehensive and accurate account of real-time reading processes.

In relation to the intervention research discussed in the review in Chapter one, none of the papers made explicit reference to the use of a model in their research. The present study aims to contribute to the research on models of reading comprehension by using both developmental and information processing models in the analysis and discussion of each participants' results. This is likely to result in a more robust interpretation of the data. The following section will conclude the literature review and summarize the chapter on developmental and information processing models for reading.

2.4. SUMMARY OF CHAPTER:

This first section of this chapter discussed developmental phase models, separated into those that describe development of decoding and word recognition (e.g. Ehri, 1995; Frith, 1985; Høien and Lundberg, 1988) and those that include aspects of speech and language development (Chall, 1967, 1996; Stackhouse & Wells, 1997). All phase models of word recognition and decoding described a gradual progression from phonological to orthographic processes for reading. However, Frith's three phase model was discussed in the most detail, as this is one of the earliest and most influential in the field, that became the springboard for models developed by Ehri (1995) and Høien and Lundberg (1988). The focus then shifted to developmental models by Stackhouse and Wells (1997) and Chall (1967, 1996) that showed the progression of both speech and/or language and literacy development. These models that considered the role of oral language are of particular relevance to this study because they

support the view that oral and written language develop on a continuum. The section on developmental models concluded by stating that a combination of Ehri's and Chall's models will be used for analysis and discussion in this study. A combination of these two models will enable the most detailed description of reading that can be applied to clinical practice. Considering the roles of language comprehension and decoding allows for a more comprehensive understanding of a child's reading development as a whole, and thus will be most suitable for this study.

The second section of this chapter described single route and dual route information processing models. Single route models are supported by analogy and connectionist theories, however they received criticisms for not adequately explaining all of the processes in reading. Therefore a large body of literature is in support of dual route information processing models as they provide the most comprehensive descriptions of how real words, exception words and nonwords are read. Ellis and Young (1988, 2002) developed a functional model for the recognition, comprehension and naming of written words, which was discussed in greater detail in the body of this chapter. This model is one of the more detailed dual route models that considered the role of oral language in reading. For these reasons, Ellis and Young's (2002) model will be used for the analysis and discussion of the participants' real-time reading processing in this study.

This concludes the review of the literature on reading for this study. The following chapter will outline and describe the methodological practices that were used in this single subject intervention study.

CHAPTER THREE: METHODOLOGY

3.1. INTRODUCTION TO CHAPTER:

This chapter will describe the procedures and rationales for this single subject intervention study. The chapter will begin by stating the aims and objectives of the study, followed by an overview of the research design. The next section will focus on the five children who participated in the study, including the participant selection criteria, a description of each child, concluding with the sampling and recruitment methods used. The procedures employed for each participant will be explained, including the initial assessment, probe assessments, intervention planning and post-intervention evaluation. This will be followed by a description of the materials used, and the chapter will conclude by considering the reliability and validity of the study.

The aim of this chapter is to provide clear and detailed descriptions of the methods and participants in this study, which addresses the findings and interpretation of data for each case in further chapters. Throughout the research process, the study aimed to use research principles and procedures that were ethical, evidence based and supported in the literature.

3.2. AIM:

To describe the outcomes of an application (app)- based intervention for children with reading difficulties.

3.3. OBJECTIVES:

To describe the following for each participant in relation to key theoretical frameworks for understanding reading:

1. Any changes from pre to post intervention on reading comprehension scores using untreated probe items.
2. Any changes from pre to post intervention on measures of language and literacy (see Appendix E).
3. Each child's experience of the intervention.

Figure 8 indicates the relationship between Objective 1 and 2, where it can be seen that Objective 1 is focused on a fairly small and specific set of stimuli, related specifically to the intervention whereas Objective 2 is concerned with broader, more general outcomes of language and literacy (which will be measured with standardized language and literacy assessments).

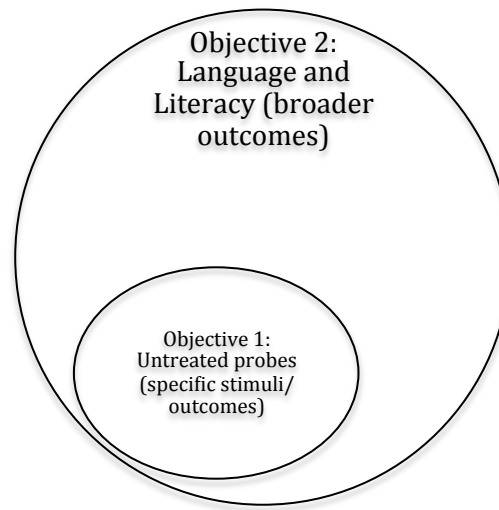


Figure 8: Schematic view of specific and more general outcomes measures used in the study.

3.4. RESEARCH DESIGN:

This study used a single subject ABA design with five children. Each child was treated as a single case and acted as his/her own control. Each child's results are presented in a separate section of the Results chapter. In each child's section, their unique language and literacy profile was described and positioned within key theoretical models for understanding reading (Bishop & Snowling, 2004; Chall, 1967, 1996; Ehri, 1995, 2000; Ellis & Young, 1988, 2002; Hoover & Gough, 1990).

Each child's pre and post intervention abilities were described and related to theoretical frameworks. More specifically, the children's abilities were detailed for each of the following measures: (1) Reading comprehension as measured by their performance on untreated, matched items (probe items); (2) more general language and literacy measures. Following this general overview of the research

design, the next paragraph will discuss some of the evidence supporting single subject designs. The subsequent section will explain the descriptive nature of this research and detail the use of control measures in the study.

The single subject design is a “rigorous, scientific methodology used to define basic principles of behavior and establish evidence based practices” (Horner et al., 2005, p. 165). This type of design is useful for expanding our knowledge of child speech and language difficulties (Lane, Wolery, Reichow & Rogers, 2007; Vance & Clegg, 2012). When these designs include an element of experimental control, they are appropriate for evaluating evidence based practices and interventions (Byiers, Reichle & Symons, 2011; Parker, Cryer & Byrns, 2006; Vance & Clegg, 2012). A single subject design was appropriate for this study as it allowed the researcher to describe the intervention outcomes for individual participants where the participant acted as his/her own control (Byiers et al., 2011; Graham, Karmarkar, & Ottenbacher, 2012; Logan, Hickman, Harris & Heriza, 2008; Parker et al., 2006; Vance & Clegg, 2012). Vance and Clegg (2012) suggested that this type of design is a robust, yet achievable way of evaluating the efficacy of interventions. The study of a small number of children has been described as the most appropriate way of detailing and understanding a novel intervention (see Vance and Clegg, 2012; Pring, 2004; Palle et al, 2004; Pascoe et al, 2005; Seeff-Gabriel et al., 2012; Constable et al., 1997). Authors such as Pring (2004) and Robey and Schultz (1998) suggest that for a novel intervention such as this one, it is appropriate to trial effectiveness with a small number of children in the first instance. These authors advise that carrying out the intervention with larger numbers, given that we do not know its value, nor the users’ perceptions of it, would be inappropriate.

For this study a descriptive design was used. Descriptive studies can describe a wide range of phenomena (Babbie & Mouton, 2005; Collingridge & Gantt, 2008) and are useful in intervention studies for accounting for the nature of a child’s difficulties and the changes that occur as a result of intervention (Barger-Anderson, Domaracki, Kearney-Vakulick, & Kubina Jr., 2004; Baylis & Snowling, 2011; Pascoe, 2006; Vance & Clegg, 2012,), particularly in the initial phases of

intervention research (Robey & Schultz, 1998). If a descriptive case study is to evaluate an intervention it must include an element of control (Barger-Anderson et al., 2004; Horner et al., 2005; Robey & Schultz, 1998; Vance & Clegg, 2012). One way to ensure control is to attempt to obtain a stable baseline prior to intervention. The use of repeated baseline measures before the intervention starts and which can demonstrate a stable baseline would support findings that any change in behavior after intervention is due to the intervention, as opposed to maturation/development (Vance & Clegg, 2012). Stable baselines are not always possible to obtain especially with children. Another form of control is to use measures such as stimuli which are not treated but matched to the stimuli being addressed, or which are untreated and from a different domain to that being targeted (Lane et al., 2007; Parker et al., 2006; Pascoe et al., 2006; Vance & Clegg, 2012).

Single subject ABA designs have been used for evaluating a number of skills and cognitive domains, e.g. decoding, expressive language, reading and spelling and it is particularly appropriate for literacy research (Barger-Anderson et al., 2004; Horner et al., 2005). This is because the systematic, detailed and experimental nature of this design lends itself to building and evaluating individualized educational and support plans (Horner et al., 2005). In addition, special classrooms are generally smaller and more contained, thus making the administration of single subject designs more useful for helping teachers evaluate the variables that impact on student learning (Barger-Anderson et al., 2004). Repeated baselines are also particularly useful in evaluating literacy when it is not possible for subjects to return to a particular baseline (Barger-Anderson et al., 2004). For example, once a learner has learnt a new strategy for decoding, it is not desirable or possible for them to lose this skill to return back to baseline. In this study, each participant was assessed several times before intervention, as well as after the intervention, which will be detailed in the procedure of this study below. Therefore this study made use of an ABA repeated measures study design (baseline phase; intervention; withdrawal of intervention and follow up assessment) (Horner et al., 2005; Lane et al., 2007; Parker et al., 2006; Parker & Vannest, 2009).

3.4. PARTICIPANTS:

3.4.1. Participant selection:

The participants were five children who met the following criteria:

- at least a grade one reading level as determined by the ESSI Reading and Spelling Test (Esterhuyse & Beukes, 1997) and/or educator report. This was to ensure a functional decoding ability.
- who had specific difficulties with reading comprehension as identified by an educator or SLT.
- who had a functional level of English communication or attended an English medium school, even if English was not their first language. This was because the iPad® application was only available in English at the time of the study.
- with sufficient visual acuity to view the application, and the ability to indicate a response by touching the iPad® screen.
- must be willing to use the app for at least 40 –to 60 minutes each week.

These criteria were deliberately broad because the descriptive, single subject design allows for focus on unique individuals. In this early stage of intervention research the focus was on exploring intervention outcomes with a wide range of children and then using these results to develop hypotheses for future studies about the children who may or may not benefit (Robey & Schultz, 1998; Vance & Clegg, 2012). Therefore this study aligned with phases one and two of the Robey and Schultz model (1998) – that is, a study of the efficacy of the intervention.

This study made use of purposive sampling as participants were selected based on their relevance to the study's main aim (Babbie & Mouton, 2005; Onwuegbuzie & Leech, 2007a). Firstly, participants who met the broad criteria of the study were selected. According to the selection criteria described above, five individuals were then purposively selected from this pool. This was to ensure that the different types of learners that were of interest to the researcher were represented (Onwuegbuzie & Leech, 2007a). As this study had a small

sample size, the researcher needed to ensure that the most relevant participants were selected (Collingridge & Gantt, 2008; Onwuegbuzie & Leech, 2007a). Parental consent and assent from the children indicated their willingness to participate in the study. This sampling method is appropriate for exploratory studies, however it is acknowledged that it is not fully representative of the population (Babbie & Mouton, 2005; Collingridge & Gantt, 2008; Onwuegbuzie & Leech, 2007a).

3.4.2. Participant description:

The children were in the age range of 7; 1 to 8; 10. Child E was the oldest participant in the study, and older than the expected age of a child in grade 2. This is because she repeated grade 1 as a result of her developmental difficulties associated with Down's syndrome. Child S and Child B were in the same class at the same school for the duration of the study, although Child B was exactly a year older, as she had started school a year later. There were four girls and one boy participant. The concerns raised by parents and/or teachers were related to reading, however concerns were also raised about Child F's word finding difficulties and Child E's developmental speech and language difficulties associated with her diagnosis. Table 6 provides a summary of the background information of the five child participants.

Table 6. Description of participants

Child	Sex	CA (years; months at the start of the study)	School grade at the start of the study	Summary of difficulties based on case notes and parent and teacher reports
G	M	7; 1	1	Marked difficulties in oral and written language related to second language learning. His overall reading ability was below average compared to his classmates.
S	F	7; 5	1	Delayed decoding and reading comprehension, performing below the average learner in her class.
B	F	8; 5	1	Moderate difficulties in oral and written language related to second language learning. Her overall reading ability was below average compared to her class mates
E	F	8; 10	2	Down's syndrome. Generally delayed oral and written language and speech, all related to her developmental disorder. She had a private facilitator to assist her with schoolwork in the classroom.
F	F	7; 10	2	Below average reading (decoding and comprehension) compared to her classmates as well as expressive word finding difficulties.

3.4.3. Method of recruitment:

The participants were identified through personal contacts, those being (1) an independent SLT with a specific interest in children with reading difficulties, and (2) an SLT and University of Cape Town senior staff member/lecturer in the Communication Sciences and Disorders division. The researcher and SLTs identified the learners who met the study criteria. A letter detailing the purpose of the study was sent to the Western Cape Department of Education (WCED), the principals of the schools and to the parents/legal guardians, with a consent form attached (see Appendices A, B and C respectively). Children whose parents/legal guardians consented to their participation in the study and who met the criteria were chosen for the study. In addition, the children themselves were invited to participate in the study and had an opportunity to ask questions and give verbal

assent (see Appendix D). This section described the participant selection, participants' background information as well as the methods of recruitment. The following sections will briefly specify the study personnel, followed by a detailed description of the procedures of the research.

3.5. STUDY PERSONNEL:

The study personnel consisted of the main researcher (a qualified and experienced SLT) who carried out the assessments and intervention in this research. The main researcher was supported by some experienced SLTs in private practice; learning support co-ordinators; an SLT who carried out the inter-rater reliability check; as well as the learning facilitators at the various schools.

3.6 DESCRIPTION OF MATERIALS:

3.6.1. Assessment material:

A battery of standardized assessments was conducted with each participant in order to obtain a pre-intervention baseline and allowed for description of each participant's language and literacy profile (see Appendix E). All of these assessments, apart from the ESSI Reading and Spelling Test (Esterhuyse & Beukes, 1997), had not yet been standardized on the local population, but were considered reliable and valid in the contexts in which they were developed (please refer to assessment manuals [Anthony, Bogle, Ingram & McIsaac, 1971; Esterhuyse & Beukes, 1997; Frederickson, Frith & Reason, 1997; Martin & Brownell, 2005; Neale, 1997; Robertson & Salter, 2007; Semel, Wiig & Secord, 2003] for more details). Specific literacy measures were re-administered directly after the intervention period in order to determine if any generalization had occurred. These specific literacy measures included the ESSI Reading and Spelling Test (Esterhuyse & Beukes, 1997) and Neale Analysis of Reading Ability Second Revised Edition (Neale, 1997), which evaluated reading and spelling of single words and reading comprehension of passages. The informal assessments used with Child E are specified in Appendix L. In order to obtain a receptive and expressive language assessment, the appropriate sections of the Reynell

Developmental Language Scales (Edwards et al., 1997) were administered and Child E's performance was interpreted qualitatively. A measure of phonological awareness and literacy was obtained by administering Phonological Awareness Test 2 (PAT 2) (Robertson & Salter, 2007) informally and interpreting her responses qualitatively.

3.6.2. Probe assessments:

Each child's ability to read and understand the stimuli included in the app-based intervention was evaluated at the end of the intervention. The probe assessments aimed to determine whether that ability was limited to only the items that had been worked with in intervention or whether generalization had occurred so that the child would be able to successfully read and understand similar items (the matched probes) that were not addressed in therapy. These items were selected from the app and were similar to the intervention items in terms of word frequency, length and imageability and were selected based on principles detailed in Pascoe et al. (2006) and Roth and Worthington (2010).

3.6.3. Fidelity checklist:

The researcher devised a checklist for the purposes of monitoring the fidelity of the intervention (see the Intervention Fidelity Checklist in Appendix F). Section A of the Intervention Fidelity Checklist was administered to the participants/caregivers/educators before each intervention session in order to document and describe any additional iPad® usage outside of the sessions. Section B of the checklist was self-administered by the researcher at the end of each intervention session (or during the session if necessary). This enabled the researcher to describe any environmental and behavioural factors that were relevant in the session. As this checklist was administered at the beginning and end of every intervention session, a measure of consistency was maintained. This information was used for later analysis and discussion, which was acceptable considering the descriptive, single case study design where each child acted as his/her own control.

3.6.4. iPad® applications:

The intervention was carried out using the Tactus Comprehension TherAppy and/or Reading TherAppy apps, depending on each participant's ability/reading level i.e. single words, phrases or sentences. The Tactus TherAppy suite of iOS apps was designed by an app programmer and SLT living in Canada. The app was specifically designed for use with adults with acquired neurogenic communication difficulties, but the developers have suggested that it may also be useful with children. The apps were designed in keeping with therapeutic principles and have been based on a basic information-processing model of input and output. Items were also presented in a linguistically structured manner (words to phrases to sentences).

Both apps are designed with a high level of flexibility/customization. Individual stimuli items can be removed if they are judged as inappropriate (e.g. culturally inappropriate, too challenging) and levels and number of items can be adjusted for individual clients. This ability to customize the app was one of the main reasons that the app was selected for use in this study, since it fitted with literature that suggested that intervention is most appropriate when tailored specifically to meet individual's needs. An important and time-consuming part of this study was the customization of the probe items for each child, and the individual nature of therapy that was given to all the participants. The app was programmed to email the outcomes of each intervention session to the researcher. This information included the number of correct items and errors that the participant obtained, as well as the exact targets with which the participant struggled. The Comprehension TherAppy app has been evaluated in the early phases of intervention research and was demonstrated to be effective in a study by Knollman et al. (2011), which focused on adults with chronic aphasia and severe auditory comprehension deficits.

For this study, the UK English dialect was selected because this had the closest resemblance to South African English dialect. The Comprehension TherAppy app was used for intervention at the single word level (see Appendix O for examples of stimuli). In this app, a single target written word appeared along with a

number of pictures above it (see Figure 9). One of the pictures matched the target word, while the other three pictures were presented as foils or distractors. There was an option for the researcher to manually select a range of foils, from numbers one to five. For this study, three foils were selected. Therefore, during the intervention four pictures appeared on the screen (three foils plus one target picture) from which the participant could select. This number was selected as this reduced the risk of guessing and ensured that the screen was not visually overwhelming or distracting.

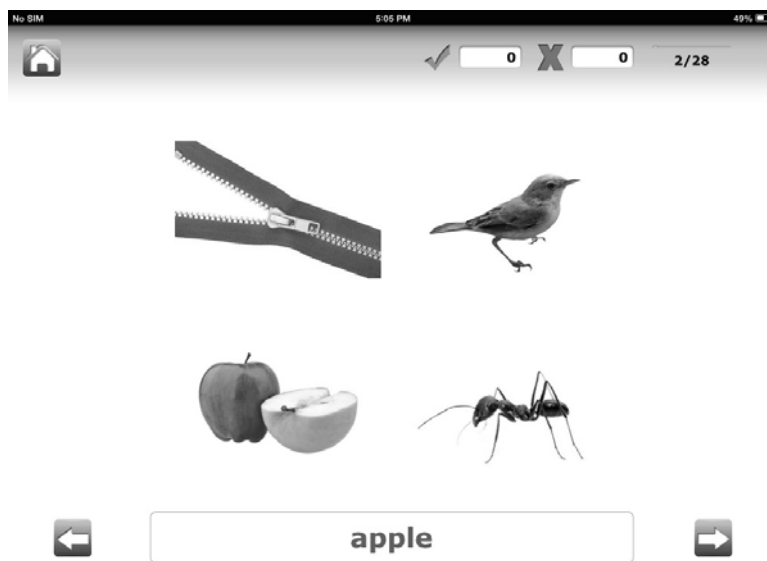


Figure 9: Screen shot of an item in Comprehension TherAppy app (Tactus Therapy Solutions)

There were three levels of difficulty within the Comprehension TherAppy app – easy, medium and hard. On the easy level, all foils were from different semantic categories (e.g. apple, pants, horse). On the medium level of difficulty, there was at least one foil from the same semantic category (e.g. apple, pear, horse) as the target and at least one foil with the same first phoneme as the target. On the hard level of difficulty, all foils were from the same semantic category or subcategory where possible (e.g. apple, pear, orange). For this study, the medium level of difficulty was selected as this created enough of a challenge for the participants, while still allowing a fair chance of success.

The Reading TherAppy app consisted of phrases and sentences and was used in the next level of intervention (see Appendix O for examples of stimuli). Within both the phrase and sentence levels, there were matching and completion tasks. For this study, only the picture matching tasks were used, in which the participant was required to match a single picture to the corresponding phrase or sentence. In this instance, the foils consisted of sentences (not pictures like in the Comprehension TherAppy app) and the number of sentence foils ranged from 2 – 4 (see Figure 10). In this app static foils were used, which meant that there were three foils written specifically for each target. There was at least one semantic foil (e.g. ‘pear’ for the target ‘apple’) and one phonological foil (‘ant’ for the target ‘apple’) for each item.

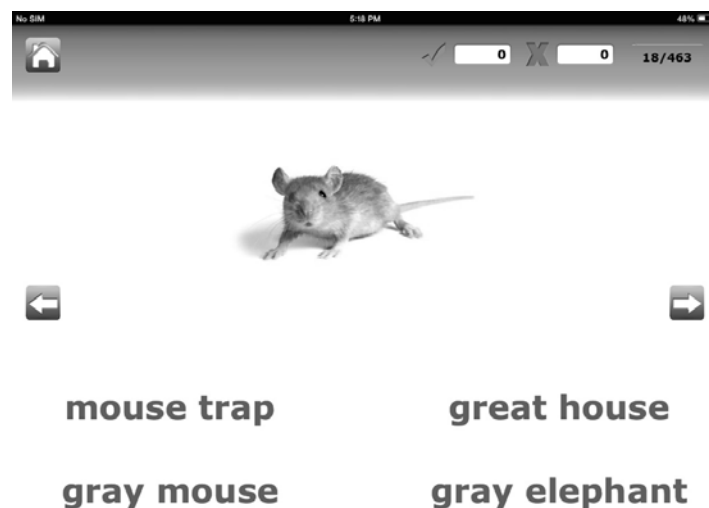


Figure 10: Screen shot of an item in the Reading TherAppy app (Tactus Therapy Solutions) at the phrase reading level.

For this study, the apps were downloaded onto an iPad mini®. Either the participant already had access to an iPad®, or if not, the researcher made an iPad mini® available only for the duration of the study, after which it was returned to the researcher.

3.6.5. Post-intervention interview schedule:

An interview schedule (see Appendix M) was used to guide the post intervention interviews with the participants. The interviews, which consisted of verbal

open-ended questions, were recorded on the iPad mini® using a voice recorder application for later transcription. Each child was interviewed with the aim of discovering more about the following areas: (1) what they enjoyed about the intervention, (2) what they did not enjoy about the intervention, (3) suggestions to improve the intervention and (4) their perceptions about their own reading ability and their enjoyment of reading. The researcher transcribed each child's interview using the recorded data and performed a content analysis following Berg and Lune (2004); Flick (2014) and Hsieh and Shannon (2005). The main themes from each interview question were documented. In the case of Child E, verbal feedback was also obtained from the facilitator in order to supplement the interview information from the child herself. This was because Child E provided limited information in the one-on-one interview with the researcher.

3.7. PROCEDURES:

As a planning activity prior to the start of the study, the researcher reviewed the pictures, words, phrases and sentences that made up the items on the apps. Every item was considered in terms of age appropriateness, cultural appropriateness and imageability (that is, clarity of the picture targets). There was a total of 800 items in the Comprehension TherAppy (Tactus TherAppy Solutions) and 1800 items in the Reading TherAppy app (Tactus TherAppy Solutions). Any items that did not meet the above mentioned criteria were documented. In order to ensure content validity, these inappropriate items were then reviewed by an expert panel, which consisted of two other SLTs from different cultural and ethnic backgrounds. Together with this expert panel, the researcher removed items from the app that were considered to be inappropriate. During this process, 82 inappropriate items were removed from the Comprehension TherAppy app and 64 were removed from Reading TherAppy app. This left 718 items in the Comprehension TherAppy app and 793 items in the Reading TherAppy that would be used for intervention and probe assessments. The following paragraphs will describe the steps and procedures of the study in greater detail, including the pilot study, and the three phases of the main study. Figure 11 provides an illustrated summary of the study's procedure that will be explained in the following paragraphs.

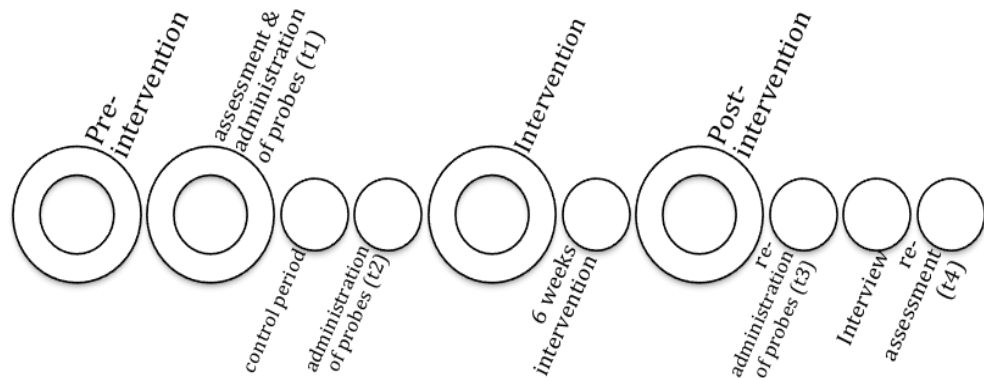


Figure 11: Outline of procedure

3.7.1. Pilot study:

Prior to the main study, a pilot study was conducted with a grade one second language learner who had grade appropriate reading ability. The purpose of the pilot study was to refine procedural elements of the study, particularly the procedure of assessment and intervention. The pilot pre-intervention phase followed the procedure of that in the actual study. Once the assessment information was obtained, the appropriate level of intervention was selected for this participant. This intervention phase for the pilot study was shortened to three 30 minute sessions in order to trial and refine the following: the selection of the appropriate intervention level (determined from the assessment results), the Fidelity Checklist (Appendix F), number of targets covered in a session, documentation of the intervention (i.e. error analysis, researcher mediation) and any other procedural difficulties that arose. No post-intervention procedures were conducted for the pilot study.

3.7.2. Pre-intervention phase:

The language and literacy skills of each participant are described in separate Results chapters. In terms of assessment, each child participant was assessed three times prior to intervention – one initial assessment of his/her language and literacy skills using standardized assessments listed in Appendix E (t1); prior to the control period using items from the relevant app (t2); and after the control period using treated and untreated probe items that were linguistically

matched to the intervention items, but not used in the intervention (t3). The pre-intervention assessments aimed to obtain a clear picture of each child's communication and reading profile. More specifically, the pre-intervention assessment phase aimed to:

- Obtain measures of each child's language, auditory perceptual, phonological awareness, reading, spelling and speech production skills using standardized assessments.
- To obtain a pre-intervention reader profile of each child, based on Bishop and Snowling's (2004) revised Simple View of Reading model.
- To obtain each child's level of reading development by using Ehri's (1995) and Chall's (1967, 1996) developmental phase models of reading.
- To evaluate each child's reading strengths and weaknesses by using Ellis and Young's (1988, 2002) information processing model of reading, which aims to tap into all aspects involved in reading to indicate areas of breakdown or difficulty.
- To obtain a list of items from the app that each child has difficulty with in order to create treatment and probe items to later evaluate effects of intervention on treated and untreated stimuli.

The discussion in this pre-intervention section will detail the assessment procedures for each participant at t1 and t2, by considering the standardized assessments, developmental and information processing models and finally the probe items.

3.7.2.1. Standardized assessments:

At t1, standardized assessments were conducted over a number of short sessions to accommodate the participants' school schedules and to avoid fatigue during testing. Four out of the five children received the same standardized assessments, as listed in Appendix E. This assessment battery consisted of four main areas, namely (1) receptive and expressive language, (2) auditory perceptual skills, (3) literacy (including phonological awareness, reading and spelling) and (4) speech production. The Clinical Evaluation of Language Fundamentals Fourth Edition (CELF 4) (Semel, Wiig & Secord, 2003) was used to

evaluate receptive and expressive language abilities and the Test of Auditory Processing Skills Third Edition (TAPS 3) (Martin & Brownell, 2005) was used to evaluate auditory perceptual skills. Literacy was evaluated using the following three tests: the Phonological Awareness Test 2 (PAT 2) (Robertson & Salter, 2007) to assess phonological awareness and grapheme-phoneme knowledge; the ESSI Reading and Spelling Test (Esterhuyse & Beukes, 1997) to evaluate sight word reading and spelling of single words; and the Neale Analysis of Reading Ability Second Revised Edition (Neale, 1997) to evaluate reading speed, accuracy and comprehension of passages. Lastly, speech production was assessed with the Edinburgh Articulation Test (Anthony, Bogle, Ingram & McIsaac, 1971). The nature of these assessments are detailed further in the material section.

Child E received different assessments to the others because she was unable to cope with the level of the standardized assessments due to cognitive and linguistic difficulties. Informal descriptive assessments that were based on formal standardized assessments were devised by the researcher and were used to assess Child E's speech, language, phonological awareness and literacy skills (see Appendix L). In these assessments, detailed descriptions of Child E's performance were provided and qualitative analyses was carried out (see Child E in Results chapter).

3.7.2.2. Developmental and information processing models of reading:

Once the assessment was completed, each child's reader profile was documented using Bishop and Snowling's (2004) adaptation of Hoover and Gough's (1990) Simple View of Reading model (see Figure 1 in Chapter one). Then, each participant's development of reading was plotted on Ehri's (1995) and Chall's (1967, 1996) developmental phase models in order to document his or her level of reading development prior to intervention (see Figure 5 for Chall's model) for later comparison at the post-intervention phase. Each child's reading strengths and weaknesses prior to intervention were discussed using Ellis and Young's (1988, 1996) information processing model of reading, which aims to tap into all aspects involved in reading to indicate areas of breakdown or difficulty.

3.7.2.3. Obtaining probe items:

After this process was completed, the level of intervention for each participant was determined. Once the relevant intervention level was individually selected for each participant, the researcher presented each participant with a number of items on the app in a random sequence (t2). The number of items that the participant had difficulty with (i.e. error, responds “I don’t know” etc.) during one hour of using the app was documented (the ‘error’ items were to be used as therapy and probe items). The number of error items obtained in one hour varied for each participant, depending on their speed and level of reading and level of concentration. The number of errors items on the app ranged from 24 to 180 in different participants. In order to eliminate the effect of learning, the participant was not given the correct answer if an error was made.

These ‘error’ items were split into two linguistically matched lists (list A and list B). These items were matched wherever possible using the following criteria: length (number of syllables); phonotactic structure; spelling rules and word frequency. List A formed the treated items in the intervention, which were then specifically selected on the app before each intervention session. Three to ten simple words were added to the intervention set in order ensure some success in the activity. List B consisted of untreated probe items that were used for the probe assessments throughout the study. These treated and untreated probe items will be described in further detail in following sections of this chapter. Table 7 below is an example of such a list (based on Child B’s errors), which is split into two linguistically matched lists (List A and List B) as described above.

Table 7. Linguistically matched lists containing the child’s reading errors on the app. List A became the treated items that were used in the intervention, while List B was used as untreated probe items.

LIST A	LIST B
1. Face	Vase
2. Screw	Artist
3. Golf	Salt
4. City	Sugar
5. Jacket	Money
6. Kite	Rice
7. Doll	Ball
8. Jigsaw	Desert
9. Bread	Square
10. Cheek	Cheese

3.7.2.4. Control period:

Once this process was completed for each individual, a two to four week control period was initiated. This control period included school holidays as well as time in school with typical teaching. Probe items from list A and list B were then re-administered (t2) in an attempt to establish a stable baseline, or indicate the degree of development that was occurring prior to intervention being initiated.

3.7.3. Intervention phase:

Once the standardized assessments and probe items were administered and the control period was over, the individualized app-based reading intervention began. The intervention phase continued for a period of approximately six weeks for each child. Each participant received four to six hours of intervention in total, and this was carried out on a 1:1 basis. In terms of the structure of the sessions, the Fidelity checklist (see Appendix F) was administered prior to every session with the participant/caregiver/educator (section A). The intervention was then conducted after which the Fidelity checklist was then self-administered by the researcher at the end of each session (section B) in order to ensure fidelity of the intervention.

The intervention was tailored to each child’s level of reading, which was determined by their assessment results. A child was moved to the next level of intervention when he/she achieved and maintained 90% accuracy or more, independently (that is, without help from the researcher), on the intervention

items. For example, if a child achieved 90% accuracy on word level items, and was able to maintain this accuracy level for two sessions, he/she was moved up to the next intervention level, which in this case would have been the phrase level.

The researcher visited the participants at their schools twice a week in order to conduct and mediate the intervention on the iPad®, monitor the child's performance and document all relevant information (i.e. participants' codes, date, dosage, correct responses, item and error analysis, cues given, level of intervention, any issues) on an excel spreadsheet for later analysis and discussion. The app also kept score of each participant's performance and the amount of direct contact time that the child worked on the app was also recorded by app. This information was automatically emailed to the researcher and stored for later analysis. The children were seen individually for intervention sessions, which were carried out in a quiet room at school (e.g. empty classroom, library). Intervention sessions were typically 30 minutes in duration. For Child E, sessions were made shorter (i.e. 20 minutes) because of her limited concentration span.

3.7.4. Post-intervention:

Once the intervention was completed, the post intervention phase began. This included the re-administration of the treated and untreated probe items in order to document any changes in reading comprehension specifically as they related to the targeted stimuli. The treated and untreated items were described in detail in the preceding section of this chapter. The administration of treated and untreated items was carried out in order to specifically evaluate:

- The efficacy of the intervention
- Whether across task generalization and/or across item generalization occurred, by examining the untreated probe items.
- If the child's reading of targeted stimuli improved with the intervention by examining the treated probe items

The researcher then interviewed each participant in order to describe his/her experience of the intervention. This interview consisted of open-ended questions and was audio recorded on the iPad® for later transcription (see Appendix M and N). The researcher transcribed each child's interview and performed a content analysis following Berg and Lune (2004); Flick (2014) and Hsieh and Shannon (2005). The main themes from each interview question were documented in a table format and are referred to in the Results chapter of this research.

Literacy measures from the initial assessment battery were re-administered in order to document maintenance and generalization of skills as a result of the intervention (see Figure 8). These standardized literacy measures included the ESSI Reading and Spelling Test (Esterhuyse & Beukes, 1997) and Neale Analysis of Reading Ability Second Revised Edition (Neale, 1997), which evaluated reading and spelling of single words and reading comprehension of passages. At the end of this phase, the participants' level of reading development was once again plotted on Ehri's (1995) and Chall's (1967, 1996) developmental model, in order to evaluate if they had progressed to a higher level of reading development. This same process was completed for each participant using Ellis and Young's (1988, 2002) information-processing model. The interview and standardized assessments of the post-intervention phase aimed to determine the following:

- If the child made gains on standardized literacy measures in relation to their peer group
- If the child's level of reading development on Ehri's (1995) and Chall's (1967, 1996) models had changed from the initial level of reading development
- If the child's reading strengths and weaknesses had changed from the initial profile, according to Ellis and Young's information processing model of reading (1988, 2002).
- To describe the child's perception of the intervention and their reading abilities.

Due to time constraints, receptive and expressive language could not be re-assessed at this phase.

3.8. DATA ANALYSIS:

This included the use of t-tests to compare changes in probe items over time (from t1 to t2 and from t2 to t3) and across lists (treated and untreated lists). T-tests were calculated using the following online program:

<http://www.graphpad.com/quickcalcs/ttest2/>. Line graphs were also constructed in order to conduct a visual analysis on the probe data.

In terms of interview data analysis, the researcher transcribed each child's interview using the audio recorded data and performed a content analysis following Berg and Lune (2004); Flick (2014) and Hsieh and Shannon (2005). The main themes from each interview question were documented and summarized in a table format.

3.9. RELIABILITY AND VALIDITY:

Reliability is defined as the consistency of a technique or result when measured repeatedly under the same conditions, each time (Babbie & Mouton, 2005; Morse, Barrett, Mayan, Olson & Spiers, 2008; Pascoe et al., 2006). This includes both intra-rater and inter-rater reliability (Irwin et al., 2008). Intra-rater reliability refers to whether the researcher made similar findings on repeated observations (Irwin et al., 2008). Following other similar studies in linguistics and education, intra-rater reliability was considered by taking a sample of the assessment data (i.e. 10-20% of the language and literacy data from the assessments) and having the main researcher re-transcribe / score and analyze this. Agreement between the researcher's two analyses was within the boundaries of a 95% confidence level, as used in a studies by Baylis and Snowling (2011); Bowyer-Crane et al. (2007); Burgoyne, Duff, Snowling, Buckley and Hulme (2013) and Clarke et al. (2010).

Inter-rater reliability is the extent to which two or more individuals agree on a result or finding (Irwin et al., 2008, Long & Johnson, 2000). This study obtained

inter-rater reliability by giving a subset of the data (10-20% for each child) to another SLT who was uninvolved in the study. The extent to which the researcher and SLT agreed provided a measure of consistency of the research procedure and findings (Irwin et al., 2008; Pascoe et al., 2006; Silverman, 2010). This agreement was also within the boundaries of a 95% confidence level. In addition, the participants' scores were measured and recorded by the app itself. This objective measure eliminated the risk of human error. The researcher also used the checklist (see Appendix F) at the beginning and end of every session to ensure that the fidelity of the intervention was maintained.

Validity is defined as the extent to which a measure accurately reflects what it claims to measure (Babbie & Mouton, 2005; Morse et al., 2008; Onwuegbuzie & Leech, 2007b; Pascoe et al., 2006; Whittemore, Chase, & Mandle, 2001) – in other words, the credibility of the research (Silverman, 2010, p. 366). Firstly, the probes that were used for the multiple assessments (for obtaining the stable pre-intervention baseline and post intervention measures) were designed using stimuli design principles based on Pascoe et al. (2006) and Roth and Worthington (2010). The researcher also carefully monitored and documented each participant's intervention and behaviour with the use of the Intervention Fidelity Checklist (see Appendix F) and field notes taken at each visit. This ensured that the following relevant information was captured: participants' codes (coding to ensure anonymity), date, dosage, correct responses, item and error analysis, cues given, level of intervention, as well as any issues that arose. The checklist was administered with the participant/caregiver/educator before each session where appropriate (section A) and was self-administered by the researcher herself after each session (section B). Therefore any relevant information pertaining to iPad® usage, the intervention environment and the participants' behavior was also consistently documented. The researcher administered the checklist at every session, thereby improving the authenticity of the intervention. As the number of participants was relatively small, quality and control of the assessments, intervention and the entire research process itself was properly maintained. This together with the extended period of

therapy, regular visits and monitoring of intervention by the researcher improved the quality of the research.

The standardized assessments listed in Appendix E have not been standardized on the South African population, however their reliability and validity have been established in the American/UK populations. As each participant was treated as a single case, the tests were used to describe each participant's unique psycholinguistic profile. Once the intervention was completed these tests allowed for within-subject comparison on language and literacy measures.

3.10. ETHICAL CONSIDERATIONS:

Ethical matters arise out of the researcher's interaction with other people and environments (Babbie & Mouton, 2005; Silverman, 2010). The revised Helsinki Declaration (2008) stated that researchers should abide by the following ethical principles throughout the research process. This project has received Ethical clearance through the Human Research Ethics Committee, Faculty of Health Sciences of the University of Cape Town No. 483/2013 (see Appendix G). The ethical principles of autonomy, beneficence, non-maleficence and justice will be discussed in the following paragraphs. This section will conclude with a brief section of the risks and benefits to the participants of the study

3.10.1. Autonomy (informed consent):

All research should be guided by respect for individuals (Orb, Eisenhauer & Wynaden, 2001). This means that the individual has the right to be informed about the study, to participate freely and to withdraw from the study at any point (Miller & Bell, 2002; Orb et al., 2001; Richards & Schwartz, 2002). This principle is honored by informed consent. As the children that participated in this study were young and within the vulnerable population, they were not able to give informed consent. Therefore, the parent/legal guardian was required to give informed consent, while the child was required to give verbal assent (see Appendix D). In order to honour the principle of autonomy, those who took part in the study were made aware that participation is voluntary, and that they were

free to withdraw from the study at any time with no repercussions. The children's legal guardians were informed that participation was not forced and this was communicated to the children as far as possible. In addition, the participants' were made aware that their decision to partake in the study had no effect on the SLT services that they were currently awaiting (i.e. their place on a SLT's waiting list for therapy) or receiving (i.e. current therapy with their regular SLT). The participants' identity was also strictly protected and the researcher ensured that confidentiality and anonymity were upheld (Babbie & Mouton, 2005). For this study, each participant was given a code (e.g. Child B, Child E) and no identifiable biographical information was included in the report.

3.10.2. Beneficence:

The researcher had a duty to uphold the principle of beneficence by ensuring that the participants benefited from the study and that no harm came to them (Flick, 2014; Orb et al., 2001). This study upheld beneficence because the participant's reading comprehension skills improved as a result of the intervention and their experience of the intervention was positive. This study had minimal risks for the participants, which meant that no harm came to them as a result of participating in the study.

3.10.3. Non-maleficence:

The researcher was compelled to actively avoid causing harm to the research participants (Beauchamp, 2007; Mishna, Antle & Regehr, 2004). As this study had no risks for the participants, no harm came to them as a result of participating in the study. In addition, the researcher conducted the assessment and intervention at the participants' schools, giving them breaks between and encouragement as required.

3.10.4. Justice:

The researcher achieved justice by ensuring that all participants were treated fairly throughout the research process (Beauchamp, 2007; Flick, 2014; Mishna et

al., 2004). This meant recognizing the vulnerability of the population and their contributions to the study. Participants of this study were identified using the already mentioned criteria. The study aimed to recruit children with identified difficulties through private SLTs and those working in mainstream schools. Findings from this study may ultimately benefit a larger population of children with reading difficulties.

3.10.5. Risks and benefits of study for participants:

Babbie and Mouton (2005), Mishna et al. (2004) and Richards and Schwartz (2002) stated that participants should be fully aware of any possible risks and benefits of a study. For the present study, there were no risks to the participants and the participants also benefit from the intervention. If the child made remarkable improvement with the iPad®, the researcher used this as evidence to advocate for the child's therapist/parent/school to acquire one. A letter was also sent out to the participants' parents/legal guardians in which the details of the study were explained.

3.11. SUMMARY OF CHAPTER:

This chapter has detailed the methods used in this single subject intervention project and introduced the participants. It was emphasized that each child was treated a single case despite undergoing a similar structure of the research procedure. Each child received individualized assessment and app-based reading intervention for their unique reading needs, as outlined in the three phases of this study, namely the pre-intervention, intervention and post-intervention phases. The intervention phase consisted of standardized assessments and administration of probe items. This was followed by a control period/baseline phase after which the intervention began. After six weeks of intervention, literacy measures and probe items were re-administered. This, together with a child interview made up the post intervention phase. The features and structure of the iPad® apps and probes were then described.

Another point that was emphasized throughout this chapter was the use of models that guided the assessment and intervention of each case. This included

Bishop and Snowling's (2004) adaptation of the Simple View of Reading model that was used to document each child's reader profile, as well as developmental models (Chall, 1967, 1996; Ehri, 1995) and information processing models (Ellis & Young, 1988, 2002). Each child's development and strengths and weaknesses were plotted on the relevant models at the outset of the study, and again after the intervention was completed. In this way, post-intervention changes in their reading development and reading strengths and weaknesses could be described. This chapter also considered issues of reliability and validity; and concluded with a description of the ethical principles upheld in this research.

The following Results chapter will describe the background information, pre-intervention phase outcomes, intervention and post-intervention phase findings for each individual child. The implications of these outcomes will be discussed later in the Discussion chapter.

CHAPTER FOUR: STUDY FINDINGS

4.1. INTRODUCTION TO CHAPTER:

This chapter aims to outline the findings of this single subject intervention research designed to address the reading difficulties experienced by five children. Each participant's results will be described in a separate section of this chapter. The findings of each participant will be organized into the following headings:

(1) Background information:

This subsection will describe the relevant background information for each child and will include biographical, developmental, medical, family, scholastic and therapeutic history (where applicable).

(2) Pre intervention findings:

This will outline the findings from the standardized assessment battery that was administered in the pre-intervention phase. Following this, the child's reading development and strengths and weaknesses will be described in relation to the key developmental models (Chall, 1967, 1996; Ehri, 1995), information processing models (Ellis & Young, 1988, 2002) and Simple View of Reading model (Bishop & Snowling, 2004) described in Chapter One. Strengths and weaknesses on standardized assessments will be determined by considering the percentile ranks of the participants' scores

(3) Intervention:

This subsection will detail intervention dosage and levels of intervention. The Fidelity Checklist was referred to before and after every session in order to ensure consistency and to document any important information relating to iPad® usage, the environment and the child's behaviour. This section will also include a summary of the child's behaviour/attention throughout the intervention and will provide a brief description of the intervention setting/environment.

(4) Treated and untreated probes:

Each child's ability to read and understand the stimuli included in the app-based intervention was evaluated at the end of the intervention. The probe assessments aimed to determine whether that ability was limited to only the items that had been worked within intervention (treated items) or whether generalization had occurred for matched items that were not addressed in therapy (untreated probes). These items were selected from the app and were similar to the intervention items in terms of word frequency, length and imageability and were selected based on principles detailed in Pascoe et al. (2006) and Roth and Worthington (2010). Each child's performance on the treated and untreated probe items will be shown on line graphs and in tables. T-tests were used to compare their performance across time (from t1 to t2; from t2 to t3) and across lists (comparing treated and untreated lists). Line graphs were constructed in order to perform a visual analysis of the data.

(5) Post intervention outcomes:

In this subsection, each child's performance on post-intervention reading and spelling measures will be detailed in order to determine if he/she made gains on standardized literacy measures in relation to their peer group. Their post intervention literacy results are tabulated and described. Following from this, the child's developmental reading phase (Chall, 1967, 1996; Ehri, 1995) and reading strengths and weaknesses (Ellis & Young, 1988, 2002) will be explained in accordance with the relevant models.

(6) Child summary:

After each child's section, a brief summary of the relevant information and intervention outcomes will be provided.

The child interviews will be outlined in the following section and will be summarized in a table format. Common themes and differences among participant responses will be described. The implications of this intervention will be explored in the Discussion Chapter (Chapter Five).

4.2. CHILD G:

4.2.1. Background information:

At the start of the study, Child G was a 7;1 year old grade one learner (see Table 6 for description of the participants). At the time of assessment he attended a government English-medium school in the Cape Metropolitan area. Child G is a second language learner. He was born in The Democratic Republic of Congo and his home language is French. At the time of the study he had been at the school, learning English, for approximately one year. At this stage he was able to follow some simple instructions and conversational questions and was able to express himself in short sentences, although he struggled with a limited vocabulary and grammar.

There was no significant birth, medical, or developmental history reported. At the time of the study, G was already receiving Speech Therapy for language stimulation purposes. His teacher initially referred him to SLT in the second term of grade 2 as she was concerned that his language difference was affecting his learning, participation and social interaction in the classroom. His family was able to afford private SLT three times a month in order to address this. The next section will describe the pre-intervention findings in relation to the key developmental and information processing models used in this study.

4.2.2. Pre intervention findings:

4.2.2.1. Summary of assessment findings:

Child G's main difficulty was in the language domain, as he scored in the significantly below average range on both receptive and expressive language subtests (for detailed assessment scores, see Appendix H). This was likely due to second language learning and the minimal exposure he had had to English. He performed better on language subtests that contained extra contextual information along with visual support (i.e. Sentence Structure in the CELF 4 (Semel, Wiig & Secord, 2003)) as well as those targeting sequential and working memory.

Although his phonological awareness was average overall, he had some difficulty with rhyme production and blending of syllables. His strengths in other areas of phonological awareness (e.g. segmentation, isolation, grapheme-phoneme correspondence, manipulation) compensated for these difficulties, which resulted in the overall average score. His reading of sight words was age appropriate, however he struggled with spelling of single words. As he did not pass the spelling screener, the researcher was unable to continue with the formal spelling assessment. Child G's reading comprehension, rate and accuracy were all within normal limits for a child his age. This may be because classroom learning has focused mainly on written language, resulting in better developed written language skills. The fact that the input was visual as opposed to auditory (i.e. written as opposed to verbal language), may have contributed to his improved reading performance, together with the visual support in the form of a picture that accompanied the text.

Child G often substituted "th" for /f/ in all word positions (e.g. 'thing' pronounced as 'fing'), which is likely dialectal, as he is a first language French speaker. The next section will discuss Child G's reading development and strengths and weaknesses in relation to the relevant developmental and information processing models by Chall (1967, 1996), Ehri (1995) and Ellis and Young (1988, 2002) respectively.

4.2.2.2. Developmental and information processing models:

Firstly, Child G's reading development will be plotted on Ehri's (1995) four phase model of reading development as well as Chall's (1967, 1996) six-phase model of reading development (Figure 5). After this, his reader profile will be described according to Bishop and Snowling's (2004) adaptation of the Simple View of Reading model. Finally, his pre-intervention reading strengths and weaknesses will be discussed using Ellis and Young's (1988, 2002) functional model for the recognition, comprehension and naming of written words in reading (Figure 7).

In terms of reading development, Child G was at the full-alphabetic stage, which is characterized by sight word learning and a full knowledge of the alphabetic

principles and grapheme-phoneme correspondence rules. Child G's initial assessments of sight word reading. His sight-word reading was found to be appropriate, as tested by the ESSI Reading and Spelling Test. As evidenced in the assessment of phonological awareness in the PAT 2, his knowledge of graphemes-phoneme correspondence rules was average for a child of his age, which suggests a solid foundation of alphabetic principles.

According to Chall's six-phase model of reading development (Figure 5), Child G was in phase two. This phase usually starts when a child is in grades one and two, when conventional reading begins with the learning of decoding and word recognition. At this stage of reading development, there is generally more of a focus on mastering the skills of decoding and word recognition, as opposed to understanding the text (Chall, 1967, 1996).

Spoken and written language develop on a continuum and development of the former is crucial to that of the latter (Catts, Bridges, Little & Tomlin, 2008; Nation, Cocksey, Taylor & Bishop, 2010; Nation, Snowling & Clarke, 2007; Snowling & Hulme, 2010). Therefore although being able to decode a word is a necessary first step in reading, it does not imply that adequate comprehension will follow. This relationship between decoding words and comprehension was represented by Bishop and Snowling's (2004) two-dimensional model (see Figure 1). This model represents how decoding and phonological skills interact with language comprehension skills to describe different types of readers. According to this model, Child G fits the criteria of quadrant D because his phonological skills are adequate, but his non-phonological language skills are significantly delayed as a result of second language learning. Therefore this model would classify him as a "poor comprehender" as his poor language skills put him at risk for reading comprehension problems later on in his reading development. This notion is supported by Chall's developmental model, that describes a greater focus on higher level language, metacognition and comprehension of the text as a child progresses to higher grades and phases of development. Child G may have difficulties in the development of these phases as he progresses.

The dual route information processing model described by Ellis and Young (1988, 2002) will be used to describe Child G's strengths and weakness in processing spoken and written words. Child G's spoken and written word processing profile contained the following strengths:

- An appropriate visual analysis system as tested by visual identification of graphemes and words.
- An effective grapheme-phoneme conversion system as evidenced by his ability to correctly identify grapheme-phoneme correspondence and sound out (segment and blend) the phonemes of words for decoding.
- An appropriate visual input lexicon, as evidenced by age appropriate sight word reading.
- Generally effective speech production, besides for the 'th' sound in spoken words which was likely dialectal.

In addition to this, Child G's processing profile also contained some weaknesses, particularly relating to processing of spoken language. These included the following:

- A limited auditory input lexicon as tested by identifying familiar or known words.
- A poor semantic system as evidenced by his poor knowledge of word meanings/vocabulary
- A limited semantic store contributes to limited speech output, which was tested in verbal naming and vocabulary production tasks.

4.2.3. Intervention:

Child G received a total of six and a half hours of intervention. This was equally divided into intervention at the single word level and phrase level. He progressed to the phrase level when he was able to maintain 90% or more correct responses consecutively for two sessions. The individual sessions ranged from 25 to 35 minutes in length and were conducted in a quiet room at his school during the school day.

The Fidelity Checklist (Appendix F) was conducted before and after every session in order to ensure consistency and to document any important information relating to iPad® usage, the environment and his behaviour. Child G did not have access to an iPad® outside of the intervention sessions. He generally behaved appropriately and actively participated in the intervention sessions. On some occasions, he was impulsive, as he was quick to select items on the app before reading them properly. This may have been related to excitement and eagerness to experience/work on the tablet. On some occasions he was distractible and played with other buttons on the app. However, he responded well to verbal feedback and positive verbal reinforcement from the researcher. Child G appeared to be motivated by the app's scoring facility (a score of correct and incorrect responses appeared on the top right corner of the screen) and he enjoyed seeing the number of correct responses he obtained during the session.

4.2.4. Treated and untreated probes:

Figure 12 (a and b) and Tables 8 and 9 depict changes from the time of initial assessment (t1), baseline/control period (t2) to post intervention (t3) for treated (List A) and untreated (List B) probe items at the single word and phrase reading levels. The percentage refers to the items that Child G scored correctly in probe assessments of treated (List A) and untreated (List B) items.

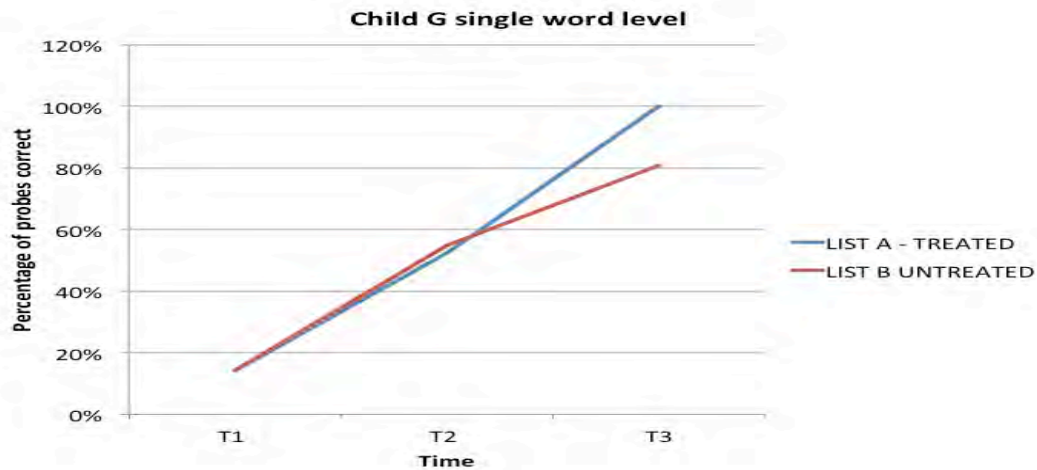


Figure 12a. Child G's changes over time for treated (List A) and untreated (List B) probe items at the single word level

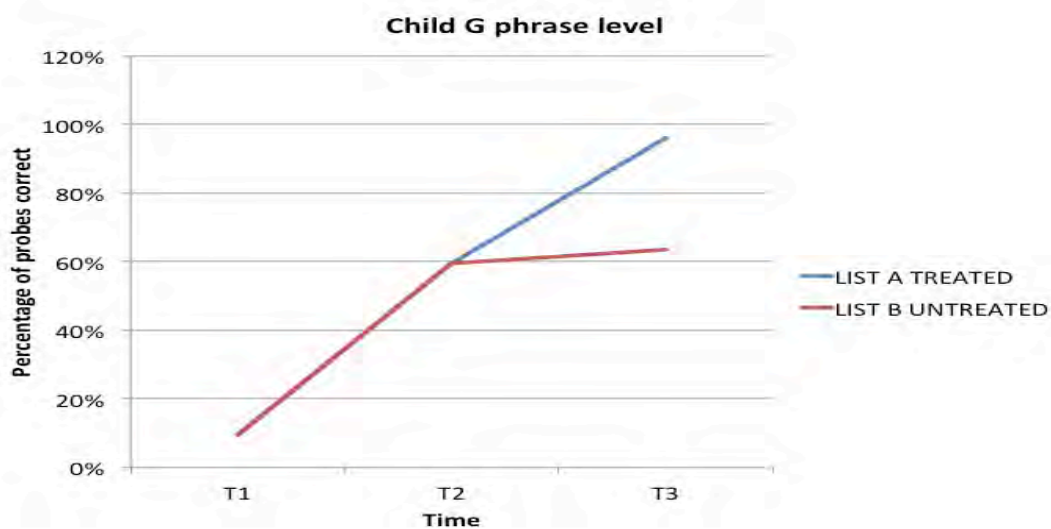


Figure 12b. Child G's changes over time for treated (List A) and untreated (List B) probe items at the phrase reading level.

Both graphs (12a and b), show an increasing trend in the data as time progressed. There was also variability of the data across time, resulting in an unstable pre intervention baseline from t1 to t2. Child G's performance on the treated and untreated probe items increased equally at t1 (initial assessment) and t2 (pre intervention, after a baseline control period). From t2 to t3 (post intervention), the treated lists improved more than the untreated lists.

Therefore, despite the variability in the data points, the intervention was successful at improving his reading of treated words.

Table 8. Comparison over time for Child G's treated and untreated, matched single word items.

TIME	LIST A - TREATED	LIST B - UNTREATED
T1 (initial)	6/42 (12%)	6/42 (12%)
T2 (pre intervention)	22/42 (52%)	23/42 (55%)
T3 (post intervention)	42/42 (100%)	34/42(80%)

Table 9. Comparison over time for Child G's treated and untreated, matched phrases.

TIME	LIST A - TREATED	LIST B - UNTREATED
T1 (initial)	5/52 (10%)	5/52 (10%)
T2 (pre intervention)	31/52 (60%)	31/52 (60%)
T3 (post intervention)	50/52 (96%)	33/52 (63%)

At t1, both lists were equally matched for both reading levels. A significant improvement occurred across time in both lists for both reading levels. From t1 to t2 there was a significant improvement on both treated and untreated lists. For list A at the single word and phrase levels, the improvement from t1 to t2 was statistically significant (single word: $t(41)=4.3434$, $p < 0.0001$; phrase: $t(51)=7.1414$, $p < 0.0001$). For list B at the single word level, the improvement from t1 to t2 was also significant ($t(41)=3.7881$, $p = 0.0005$), however this was not the case at the phrase level. Improvement during the baseline control period was likely due to maturation and development. This was also likely influenced by the heavy focus on reading and literacy in the classroom, which may have contributed to this improvement during the control baseline period.

From t2 to t3 there was also a significant improvement on both treated and untreated lists. At the single word and phrase level, the improvement from t2 to t3 was statistically significant for list A (single word: $t(41)=6.7157$, $p < 0.0001$; phrase: $t(51)=5.4188$, $p < 0.0001$). For list B, the improvement from t2 to t3 was statistically significant at the single word level ($t(41)=3.3439$, $p = 0.0018$) but not at the phrase level.

The most interesting finding occurs when the improvement is compared across treated and untreated lists. At t3, list A improved significantly more than list B at both the single word level ($t(41)=3.114$, $p=0.0034$) and phrase ($t(51)=4.2843$, p

< 0.0001) reading levels. This suggests that the intervention improved Child G's ability to read treated items (list A) significantly more than untreated items (list B). The difference between the treated and untreated lists at t3 shows that his reading of targeted stimuli improved with the intervention and that as yet the carryover to the untreated words is minimal.

4.2.5. Post intervention outcomes:

4.2.5.1. Post intervention literacy measures:

As shown in Table 10 and Appendix H, Child G's reading of sight words and spelling of single words on the ESSI Reading and Spelling Test (Esterhuyse & Beukes, 1997) improved from pre to post intervention. Although his reading remained in the average range, the percentile rank improved significantly from 23 to 77. At the time of the initial assessment in the pre-intervention phase, Child G did not pass the screener and spelling was unable to be evaluated further (according to the rules of the ESSI Reading and Spelling Test (Esterhuyse & Beukes, 1997)). His spelling improved at the post intervention assessment, as it was within the average range for a child of his grade (60th percentile). These results show that his reading and spelling had improved in relation to a typically developing peer group.

His reading rate, accuracy and comprehension of passages were re-evaluated using the Neale Analysis of Reading Ability Second Revised Edition (Neale, 1997). Overall, his post-intervention performance for rate, accuracy and comprehension remained within the average range compared to the pre-intervention assessment (see Table 11 and Appendix H). When compared from pre to post intervention, his reading comprehension percentile rank dropped from a percentile rank of 30 at pre intervention to 18 at post intervention. His rate of reading improved from a percentile rank of 20 at pre-intervention to 55 at post-intervention, suggesting that his reading fluency improved. This faster reading rate at post intervention may have contributed to his lower reading comprehension percentile rank, as he may have allocated less attention to understanding the text and more attention to reading fast/fluently.

Table 10. Comparison of Child G's performance on the ESSI Reading and Spelling Test (Esterhuyse & Beukes, 1997).

SUBTEST	Pre-intervention		Post-intervention	
	PERCENTILE RANK*	INTERPRETATION	PERCENTILE RANK*	INTERPRETATION
Reading of sight words	23	Average	77	Average
Spelling of single words	n/a	Did not pass screener	60	Average

Table 11. Comparison of Child G's performance on the Neale Analysis of Reading Ability 2ND Revised Edition (Neale, 1997).

SUBTEST	Pre-intervention		Post-intervention	
	PERCENTILE RANK	INTERPRETATION	PERCENTILE RANK*	INTERPRETATION
Accuracy	20	Average	30	Average
Comprehension	30	Average	18	Average
Rate	20	Average	55	Average

4.2.5.2. Developmental and information processing models:

In this section, Child G's reading development, and strengths and weakness at the post intervention phase will be explained. This will also be explained in relation to the models by Chall, (1967, 1996), Ehri (1995) and Ellis and Young (1988, 2002).

In relation to the developmental reading model Ehri (1995), Child G's reading development remained much the same as the pre-intervention phase - after receiving intervention, he was still considered to be in Ehri's full alphabetic phase. However, post intervention assessments revealed an improved sight word reading ability and improved reading fluency, which suggests that Child G was progressing to Chall's third stage of reading development. This third phase is characterized by a more efficient reader with consolidated decoding skills, an increased sight word lexicon, and improved reading fluency. Although his decoding skills were not fully consolidated, his reading fluency and sight word reading ability improved. This situates him at the beginning of Chall's third phase.

The rationale behind Child G still being at the full alphabetic phase of Ehri's model is that his decoding skills were not fully consolidated. A reader in the consolidated alphabetic phase, which is similar to Frith's orthographic phase, is able to rapidly analyze orthographic components without relying on grapheme-phoneme correspondence rules. At the time of post intervention assessment, Child G was not able to do this as he still used grapheme-phoneme rules to decode some words (e.g. sounding out each of the letters in a word), as opposed to using more mature decoding strategies or sight word reading.

Ellis and Young's (1988, 2002) information processing model of spoken and written words will be used to detail strengths and weaknesses at the post intervention phase. In this model, Child G's weaknesses were mostly related to processing of spoken language because of second language learning. As no standardized spoken language assessments were conducted in the post intervention phase, it is not possible to comment on any improvement related to processing of spoken words. His class teacher identified an improvement in his oral language communication skills in the classroom environment.

4.2.6. Child summary:

Child G is a second language learner who was in grade one at the start of the study. As a result of his second language learning, he struggled with language comprehension and expression in English. This resulted in scholastic difficulties and poor classroom participation. He received a total of six and a half hours of the app-based reading intervention at the single word and phrase reading levels. Child G's reading of the items treated in the intervention improved significantly. From the pre intervention to post intervention phase, his reading development also progressed (according to Chall's model) with improved sight word reading and reading fluency, as evidenced in standardized literacy assessments.

4.3. CHILD S

4.3.1. Background information:

At the start of the study, Child S was a grade one learner of 7; 5 years of age. She was identified for this study by her teacher as she had difficulties with reading, reading comprehension and spelling compared to her classmates. She was a first language English speaker attending a private school in Cape Town's southern suburbs. In her case history, normal developmental milestones and medical history were reported. When she was in grade R, her teacher referred her for SLT and Occupational Therapy assessments because of concerns about her speech and fine motor skills. SLT assessments reported slower processing of information, delayed production of some speech sounds (that is, imprecise speech production of affricates and /r/, substitution of /t/ for 'th'), difficulty with a working memory task (recalling numbers in the reverse order) and some phonological awareness skills (rhyme identification and production and grapheme-phoneme identification). However, her receptive and expressive language skills were found to be age appropriate. Child S received SLT for the difficulties mentioned for approximately one year in grade R. At this time, she also received Occupational Therapy. By the end of the study (at the post intervention phase) she was in the second semester of grade two.

4.3.2. Pre intervention findings:

The initial step of the pre intervention phase was characterized by administration of standardized assessments (see Appendix I). For Child S, the following main areas were evaluated using the assessments described in Chapter three and Appendix I: (1) receptive and expressive language, (2) auditory perceptual skills, (3) literacy (including phonological awareness, reading and spelling) and (4) speech production. Subtests were administered over five sessions, each session ranging from 30 to 90 minutes each. The assessments were conducted over a number of shorter sessions in order to reduce fatigue. A short game was used after every few assessment tasks as a form of reinforcement.

Most of the communication skills that were assessed were found to be within typical parameters for a child of S's age. However, on further inspection her communication skills also contained a number of strengths and weaknesses. Strengths included: working memory (which may have improved since the previous SLT assessment, or may be related to improved attention), word associations, word discrimination as well as decoding of consonant-vowel-consonant (CVC) words and consonant digraphs. Weaknesses included: use of grammar, formulating meaningful and grammatically correct sentences, rhyming, isolation of sounds in words, blending of syllables and phonemes and most notably reading comprehension and accuracy of passages. Despite some areas of weakness, Child S's overall scores on many of the tests were within an average range. Her higher scores on some subtests were likely to have compensated for some of her weaknesses, resulting in an overall average score for language, auditory perception and phonological awareness. However, this was not the case for reading comprehension and accuracy of passages (i.e. longer, connected text). When faced with a more challenging and heavily loaded task of reading connected text, Child S's difficulties became more noticeable and it was harder for her to compensate. Therefore, her difficulties with blending, isolation and the language areas mentioned were likely to have affected her reading comprehension and accuracy with higher level, more cognitively loaded tasks.

4.3.3. Developmental and information processing models:

In order to describe Child S' pre intervention reading development, Ehri's four phase model and Chall's six phase model will be used. After this, her reader profile will be described according to Bishop and Snowling's model (2004) followed by a description of her pre intervention strengths and weaknesses according to Ellis and Young's (1988, 2002) model.

In terms of Ehri's (1995) model of reading development, Child S was at the full alphabetic phase, as tested by her sight word reading and her knowledge of alphabetic principles and grapheme-phoneme correspondence rules. On Chall's

(1967, 1996) six phase model of reading development, Child S was at the second phase, which is characterized by learning of decoding, such as letter-sound knowledge and word recognition and typically occurs around grades one and two. Child S's reader profile can be plotted on Bishop and Snowling's (2004) adaptation of the Simple View of Reading model (see Figure 1). On this model, she fits into quadrant D (poor comprehender), as she has difficulties with some phonological skills (e.g. blending, isolation) and some non-phonological language skills (e.g. grammar, formulating meaningful and grammatically correct sentences), resulting in poor reading comprehension and reading accuracy of passages.

Child S's strengths and weaknesses in processing spoken and written words according to Ellis and Young's (1988, 2002) information processing model will be discussed next. Child S's strengths included the following:

- An adequate auditory analysis system as evidenced by her age appropriate auditory perceptual skills.
- An appropriate semantic system as tested by understanding of word classes and vocabulary.
- An adequate visual analysis system and visual input lexicon as tested by reading of sight words.
- An appropriate grapheme-phoneme conversion system as tested by naming graphemes and decoding in the PAT 2 (Robertson & Salter, 2007).

According to Ellis and Young's model, which only considers reading at the single word level, Child S did not have any weaknesses in processing spoken or written words. This was tested in comprehension and expression of single words and sight reading of single words. It was clear that she struggled with longer, more complex spoken and written stimuli, as evidenced by her below average scores in the following areas: production of meaningful and grammatical sentences as well as reading comprehension and reading accuracy of passages. According to Oakhill et al. (2003), difficulties with reading and understanding passages is most likely due to problems with text integration and metacognitive monitoring. (as well as working memory – however this is not the case for Child S as her

working memory was adequate). This notion was further supported by Wolf (2008) and Norton and Wolf (2012) who introduced the idea of the brain's "reading circuit", which involves the rapid integration of a number of neural systems to support successful reading. This reading circuit is able to support every aspect of language as well as other relevant cognitive processes, such as working memory, attention, visual and motor skills, as well as higher level language and cognition (Norton & Wolf, 2012; Wolf, 2008). Therefore, problems with text integration and higher level cognitive skills may have contributed to her weaknesses in reading comprehension and accuracy of longer texts.

4.3.4. Intervention:

Child S received a total of six hours of intervention. Four of these hours were spent on intervention at the single word reading level, with two hours spent on phrase reading. She progressed to the phrase level when she was able to maintain 90% or more correct responses consecutively for two sessions. The individual sessions ranged from 20 to 40 minutes in length and were conducted in a quiet room at her school during or after the school day.

The Fidelity Checklist was completed by the researcher before and after every session in order to ensure consistency and to document any important information relating to iPad® usage, the environment and her behaviour. Child S had access to an iPad® at home, however she did not have the intervention apps on her iPad® at home. Some of the other apps that she had on her iPad® included games and digital storybooks. In terms of her behaviour, she was sometimes quite talkative in the sessions and spoke to the researcher about topics that interested her. At times she was also distractible, which may have been due to fatigue (sessions were often conducted at the end of a school day) or a lack of motivation or interest in the intervention task. When she was talkative or distractible, fewer intervention items were covered in the sessions as more time was spent trying to re focus her to the task at hand.

4.3.5. Treated and untreated probe items:

Figure 13 (a and b) and Tables 12 and 13 depict changes from the time of initial assessment (t1), baseline/control period (t2) to post intervention (t3) for treated (List A) and untreated (List B) probe items at the single word and phrase reading levels. The percentage refers to the items that Child S scored correctly in probe assessments of treated (List A) and untreated (List B) items.

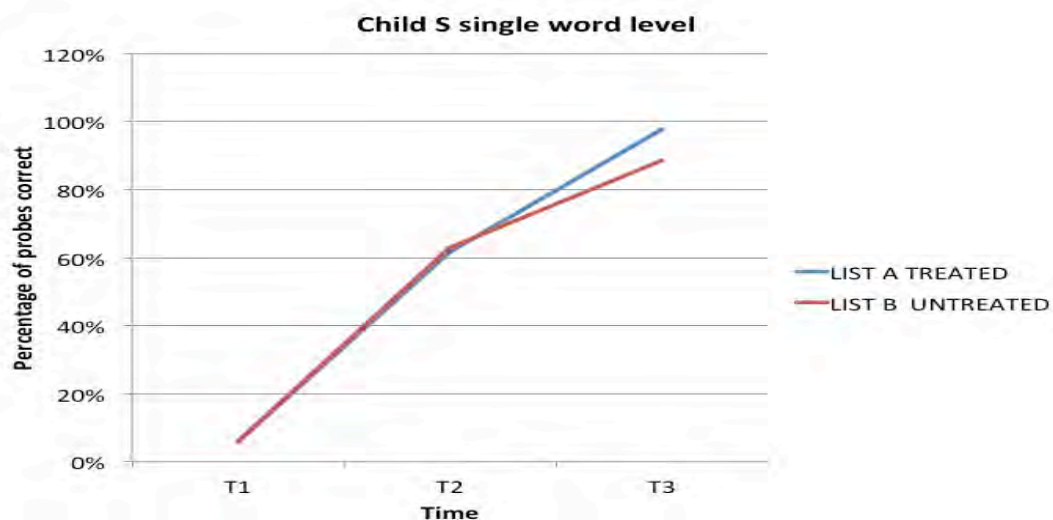


Figure 13a. Child S's changes across time for treated (List A) and untreated (List B) probe items at the single word reading level.

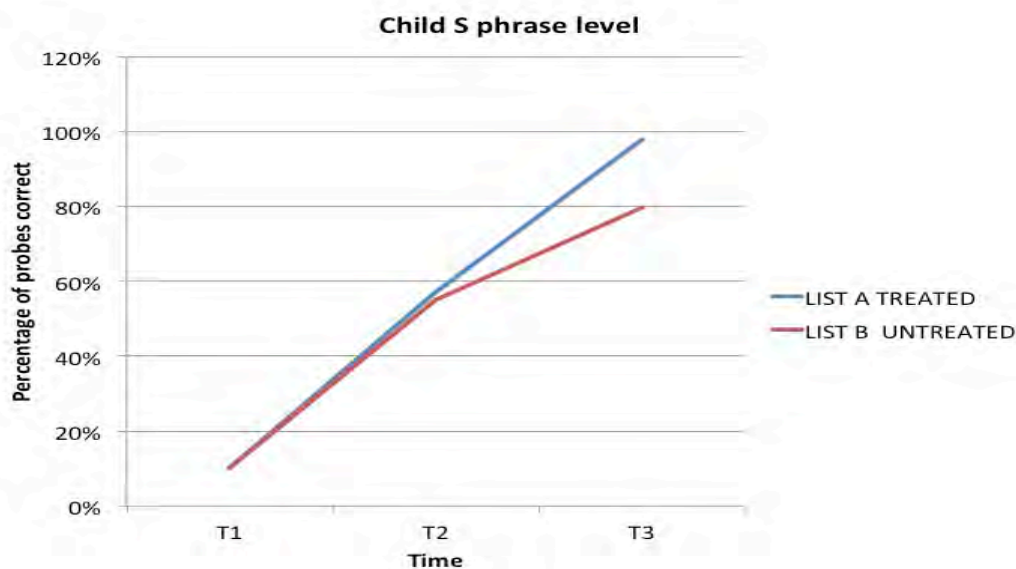


Figure 13b. Child S's changes across time for treated (List A) and untreated (List B) probe items at the phrase reading level.

On both graphs, there was an increasing trend in the data as time progressed. There was also an upward trend in the pre intervention baseline period from t1 to t2. Child S's performance on the treated and untreated probe items increased equally at t1 and t2. From t2 to t3 (post intervention), the treated lists improved significantly more than the untreated lists, suggesting that the intervention was successful at improving her reading of treated words. This increase was particularly evident in the phrase reading level graph (Figure 13b).

Table 12. Comparison over time for Child S's treated and untreated, matched single word items.

TIME	LIST A - TREATED	LIST B - UNTREATED
T1 (initial)	5/86 (6%)	5/86 (6%)
T2 (pre intervention)	53/86 (62%)	54/86 (63%)
T3 (post intervention)	84/86 (98%)	76/86 (88%)

Table 13. Comparison over time for Child S's treated and untreated, matched phrases.

TIME	LIST A - TREATED	LIST B - UNTREATED
T1 (initial)	5/49 (10%)	5/49 (10%)
T2 (pre intervention)	28/49 (57%)	27/49 (55%)
T3 (post intervention)	48/49 (98%)	39/49 (80%)

T-tests were conducted in order to determine whether the improvement across time (i.e. from t1, t2 to t3) and across lists (treated List A and untreated list B) was statistically significant. At t1, both lists were equally matched for both reading levels.

Comparison across time revealed that the difference between scores from t1 to t2 on list A was statistically significant for the single word ($t(85)=10.5307$, $p < 0.0001$) and phrase reading levels ($t(48)=6.5163$, $p < 0.0001$). This was also the case for list B, where the difference between t1 and t2 was statistically significant for the single word ($t(85)= 10.7804$, $p \text{ less } < 0.0001$) and phrase levels ($t(48)=6.0954$, $p < 0.0001$). The significant improvement that occurred from t1 to t2 in both lists for both reading levels was likely due to maturation and development. The heavy focus on reading and literacy in the classroom may have also contributed to this notable improvement during the control baseline period.

Further comparison across time also showed a significant improvement from t2 to t3. On list A from t2 to t3, there was improvement at both the single word ($t(85) = 6.8998, p < 0.0001$) and phrase reading levels ($t(48) = 5.7941, p < 0.0001$), which was also the case for list B (single word: $t(85) = 5.3952, p < 0.0001$; phrase: $t(48) = 3.9581, p = 0.0003$).

The comparison across list A and list B post intervention (at t3) at the single word level, revealed that her performance on the treated list was significantly better than the untreated list ($t(85) = 2.9526, p = 0.0041$). At the phrase level at t3, the difference between list A and list B was also significant ($t(48) = 3.2863, p = 0.0019$). This suggests that the intervention improved Child S's ability to read treated items (list A). The difference between the treated and untreated lists at t3 shows that her reading of targeted stimuli improved with the intervention.

4.3.6. Post intervention outcomes:

4.3.6.1. Post intervention literacy measures:

As shown in Table 14 and Appendix I, Child S's reading of sight-words and spelling of single words on the ESSi Reading and Spelling Test (Esterhuysen & Beukes, 1997) improved from pre to post intervention. Although her sight word reading remained in the average range, the percentile rank improved from 60 to 77. Spelling also improved from the 77th percentile in the pre intervention phase to the 89th percentile at the post intervention phase (both in the above average range). The changes indicate S's change in relation to typically developing peers.

The most notable improvement was with Child S's reading comprehension and accuracy of passages, which was re-evaluated with the Neale Analysis of Reading Ability Second Revised Edition (Neale, 1997) (see Table 15 and Appendix I). For reading comprehension of passages, there was a marked improvement from her below average pre intervention score (9th percentile) to post intervention score (20th percentile), which moved her into the average range compared to her

peers. An even greater improvement occurred in reading accuracy of passages: from a below average score (4th percentile) at pre intervention to an average score at post intervention (30th percentile). Therefore, her reading comprehension and accuracy improved on standardized measures from pre to post intervention, when compared to typically developing peers. This suggests that by the end of the intervention her overall reading skills had improved, beyond just the stimuli used in the app. Generalisation is discussed in greater detail in Chapter Five.

Table 14. Comparison of Child S's performance on the ESSI Reading and Spelling Test (Esterhuyse & Beukes, 1997).

SUBTEST	Pre-intervention		Post-intervention	
	PERCENTILE RANK*	INTERPRETATION	PERCENTILE RANK*	INTERPRETATION
Reading of sight words	60	Average	77	Average
Spelling of single words	77	Average	89	Above average

Table 15. Comparison of Child S's performance on the Neale Analysis of Reading Ability 2nd Revised Edition (Neale, 1997).

SUBTEST	Pre-intervention		Post-intervention	
	PERCENTILE RANK*	INTERPRETATION	PERCENTILE RANK*	INTERPRETATION
Accuracy	4	Below average	30	Average
Comprehension	9	Below average	20	Average

4.2.5.2. Developmental and information processing models:

Child S progressed from the full alphabetic phase (pre intervention) to the consolidated alphabetic phase of Ehri's model (post intervention). This was evidenced by improved sight word reading as well as a marked improvement in reading accuracy and comprehension of passages. This means that she had learnt new decoding strategies and was able to deal with longer, more complex texts. With regards to Chall's six phase developmental model, Child S progressed to the beginning of phase three ('efficient reader'). This phase is characterized by consolidation of decoding skills, improved sight word lexicon and increased reading fluency and accuracy. It is hypothesized that Child S was at the start of phase three, as these skills were not yet fully consolidated.

As mentioned in section 4.3.3 Ellis and Young's model was not very useful in describing Child S' processing weaknesses as the model only considered processing at the single word level. Child S's reading difficulties were evident at the sentence/connected text level when reading passages (as tested by the Neale Analysis of Reading Ability Second Revised Edition (Neale, 1997)) and therefore these could not be described using Ellis and Young's model. As supported by Norton and Wolf (2012), Oakhill et al (2003) and Wolf (2008) problems with text integration and higher level cognitive skills (i.e. working memory) are often linked to problems reading longer texts and therefore these skills may have contributed to her weaknesses in reading comprehension and accuracy of longer texts.

4.3.6. Child summary:

Initial standardized testing with Child S, in Grade 1 at the start of the study, revealed a number of strengths and weaknesses in her language, phonological awareness and literacy skills. Child S had difficulties with reading comprehension and accuracy of passages, as evidenced in the Neale Analysis of Reading Ability Second Revised Edition (Neale, 1997) assessment. Therefore her assessment profile was inconsistent, as she was good at performing some tasks, but not others. This may have been due to problems with higher level integration of skills. She received a total of six hours of app-based reading intervention, which included reading at the single word and phrase levels. Child S experienced significant improvement in reading the items treated in the intervention at both the single word and phrase reading levels. Child S also experienced more generalized positive outcomes from the intervention, particularly when she demonstrated improved reading of longer passages (as evidenced by standardized literacy measures). In terms of the overall picture, Child S' reading development progressed to the next phase of development according to both Chall and Ehri's models of reading.

4.4. CHILD B

4.4.1. Background information:

At the start of the study, Child B was 8; 5 years old and a grade one learner. She attended a private English-medium school in the southern suburbs of Cape Town. Child B was a second language learner as her first and home language was Setswana. She was first exposed to English when she started school at four years of age. Child B's teacher reported that her language and reading comprehension skills were weaker than the other children in her class. There was no significant birth, medical, or developmental history reported.

4.4.2. Pre intervention findings:

The pre intervention phase involved administration of standardized assessments (see Appendix E). The following main areas were evaluated using the assessments described in Chapter three and Appendix E: (1) receptive and expressive language, (2) auditory perceptual skills, (3) literacy (including phonological awareness, reading and spelling) and (4) speech production. Subtests were administered over five sessions, each session ranging from 30 to 90 minutes each. A short game was used after every few assessment tasks as a form of reinforcement.

4.4.2.1. Summary of assessment findings:

Child B's main areas of difficulty were language related and included difficulties with receptive and expressive oral language as well as reading comprehension and accuracy of written language (see Appendix J). These language assessments were conducted in English, which is the language of learning and teaching at her school, but not her first language. Therefore her poor scores on spoken and written language measures were related to second language learning, as all of her speech and language milestones in her first language were age appropriate. Child B's second language learning also affected her performance on the auditory comprehension subtest in the Test of Auditory Processing Skills Third Edition (TAPS 3) (Martin & Brownell, 2005), in which all other subtests assessed were in the average range.

In the Phonological Awareness Test 2 (PAT 2) (Robertson & Salter, 2007), she struggled with reading vowel digraphs and ‘magic-e’ words (see vowel Digraph and CVCe words subtests in PAT 2). Child B was a year older than the typical age of a child in Grade 1 (she was over eight years old at the time of assessment, whereas the majority of children in grade one are around seven years of age). At the time of assessment, when Child B was in the fourth term of Grade 1, reading of vowel digraphs and ‘magic-e’ words had not yet been taught in the classroom. Therefore, although the assessment shows that she may be delayed for her *age* on above-mentioned subtests, it can be concluded that this was appropriate for the level of instruction in Grade 1 term 4. This was confirmed by her scores on reading and spelling of single words, both of which were grade appropriate. Sight word reading and spelling of single words relies more heavily on a child’s decoding ability than their language skills. However, Child B began to struggle as the phonosyntactic length and linguistic complexity of the written language increased from single words in the ESSI Reading and Spelling Test (Esterhuyse & Beukes, 1997) to passages in the Neale Analysis of Reading Ability (Neale, 1997). Another significant difficulty was with reading of passages. Her scores for reading accuracy and rate in passages were significantly below average for a child of her age, while reading comprehension was below average. This reflects the connection between oral and written language – that is, Child B’s weak oral language skills in English resulted in difficulties in her comprehension of written language in English.

Her speech production (in both English and Setswana) was fully intelligible and functional.

4.4.2.2. Developmental and information processing models:

Like the two participants before her, Child B was at the full alphabetic phase of Ehri’s model and at the second phase of Chall’s model. This was evidenced by her sight word reading knowledge of grapheme-phoneme correspondence rules, which typically occurs around grades one and two.

In relation to Bishop and Snowling's model (2004), Child B would fit into quadrant D ('poor comprehender') because of the nature of her language and reading difficulties.

In terms of Ellis and Young's processing model of spoken and written words, Child B had a number of strengths and weaknesses. Strengths included:

- An appropriate visual analysis system as tested by visual identification of graphemes and words.
- A largely effective grapheme-phoneme conversion system as evidenced by her ability to correctly identify grapheme-phoneme correspondence and sound out (segment and blend) the phonemes of words for decoding.
- An appropriate visual input lexicon, as evidenced by age appropriate sight word reading.
- An effective speech production system as evidenced by her normal, intelligible speech output.

Weaknesses, particularly relating to processing of spoken language, included the following:

- A limited auditory input lexicon for spoken English words as evidenced by low language scores as a result of second language learning.
- A poor semantic system as evidenced by his poor knowledge of word meanings/vocabulary

Much like Child S, Child B's main reading difficulties were related to reading of longer texts and passages, as opposed to single words. Therefore this model is unable to adequately describe Child B's difficulties related to processing of longer, more complex written and verbal stimuli.

4.4.3. Intervention:

Child B had a total of six and a half hours of app-based reading intervention. Four of these hours were spent at the single word reading level, and two and half hours were spent at the phrase reading level. She progressed to the phrase level

when she was able to maintain 90% or more correct responses consecutively for two sessions. The individual sessions ranged from 25 to 35 minutes in length and were conducted in a quiet room after the school day.

The Fidelity Checklist was completed by the researcher before and after every session in order to ensure consistency and to document any important information relating to iPad® usage, the environment and her behaviour. Child B had access to an iPad® at home, however she did not have access to either of the intervention apps on her iPad® at home. Some of the other apps that she had on her iPad® included games. Child B's behaviour, attention and motivation were consistently good. She seemed to enjoy working on the iPad® and was motivated to improve her reading skills.

4.4.5. Treated and untreated probe items:

Figure 14 (a and b) and Tables 16 and 17 depict changes from the time of initial assessment (t1), baseline/control period (t2) to post intervention (t3) for treated (List A) and untreated (List B) probe items at the single word and phrase reading levels. The percentage refers to the percentage of items that Child S scored correctly in probe assessments of treated (List A) and untreated (List B) items.

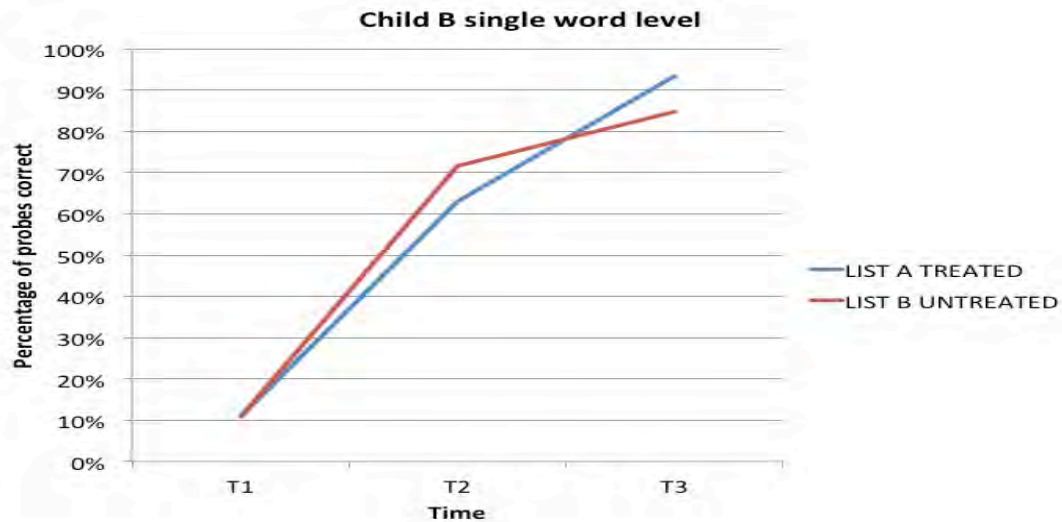


Figure 14a . Child B's changes over time for treated (List A) and untreated (List B) probe items at the single word reading level.

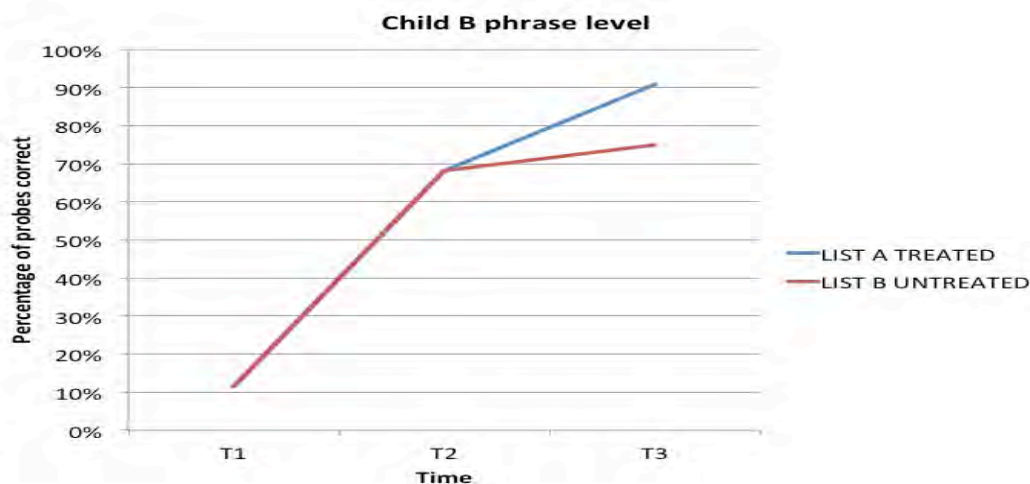


Figure 14b. Child B's changes over time for treated (List A) and untreated (List B) probe items at the phrase reading level.

Both graphs show an increasing trend in the data as time progressed. There was also an increasing upward trend during the baseline control phase from t1 to t2. At t2 at the single word level, Child B's performance on the untreated list was somewhat higher than the treated list. At the phrase level, treated and untreated probe items increased equally at t1 and t2. On both graphs, the treated lists improved significantly more than the untreated lists from t2 to t3, suggesting

that the intervention was successful at improving her reading of treated words. This shows that the intervention was successful despite the already improving trend in the pre intervention phase (from t1 to t2).

Table 16. Comparison over time for Child B's treated and untreated, matched single word items.

TIME	LIST A - TREATED	LIST B - UNTREATED
T1 (initial)	5/46 (11%)	5/46 (11%)
T2 (pre intervention)	29/46 (63%)	33/46 (72%)
T3 (post intervention)	43/46 (93%)	39/46 (85%)

Table 17. Comparison over time for Child B's treated and untreated, matched phrases.

TIME	LIST A - TREATED	LIST B - UNTREATED
T1 (initial)	5/44 (11%)	5/44 (11%)
T2 (pre intervention)	30/44 (68%)	30/44 (68%)
T3 (post intervention)	40/44 (91%)	33/44 (75%)

T-tests were conducted in order to determine whether the improvement across time (i.e. from t1, t2 to t3) and across lists (treated List A and untreated list B) was statistically significant. At t1, both lists were equally matched for both reading levels. Comparison across time revealed that the difference between scores from t1 to t2 on list A was statistically significant for the single word ($t(45)=7.0065$, $p < 0.0001$) and phrase reading levels ($t(43)= 7.6376$, $p < 0.0001$). This was also the case for list B, where the difference between t1 and t2 was statistically significant for the single word ($t(45)=8.51$, $p < 0.0001$) and phrase levels ($t(43)= 7.6376$, $p < 0.0001$). The significant improvement that occurred from t1 to t2 in both lists for both reading levels was likely due to maturation and development. The heavy focus on reading and literacy in the classroom may have also contributed to this improvement during the control baseline period.

Further comparison across time also showed a significant improvement from t2 to t3. On list A from t2 to t3, there was improvement at both the single word ($t(45)=4.4577$, $p < 0.0001$) and phrase reading levels ($t(43)=3.5675$, $p = 0.0009$), which was also the case for list B at the single word level ($t(45)= 2.5981$, $p = 0.0126$).

Comparison across treated and untreated lists at t2 revealed that there was a difference between list A and list B ($t(45)=2.0702$, $p=0.0442$) at the single word

level. Child B performed better on the untreated list. This may suggest that the two lists were not equally matched.

Further comparison across lists at t3 revealed a significant improvement on the treated list compared to the untreated lists (single words: $t(45) = 2.0702$, $p = 0.0442$; phrases: $t(43) = 2.8577$, $p = 0.0066$). This suggests that her reading of targeted stimuli improved with the intervention.

4.4.6. Post intervention outcomes:

4.4.6.1. Post intervention literacy measures:

As shown in Table 18 and Appendix J, Child B's reading of sight-words and spelling of single words on the ESSi Reading and Spelling Test (Esterhuyse & Beukes, 1997) remained unchanged from pre to post intervention assessment. Reading accuracy, comprehension and rate of passages were re-evaluated with the Neale Analysis of Reading Ability Second Revised Edition (Neale, 1997). Her reading accuracy and rate improved from pre to post intervention (see Table 19). Reading accuracy improved from the fourth percentile to the 12th percentile, moving her from the significantly below average range at pre intervention to the below average range at post intervention. Reading rate of passages also improved from the significantly below average (< 4th percentile) range to the below average range (9th percentile) compared to her peers. In terms of her reading comprehension of passages, this too remained much the same (13th to 14th percentile) from pre to post intervention, staying in the below average range compared to her peers.

Overall, the areas that improved the most were reading accuracy and rate of passages, with reading comprehension, sight word reading and spelling remaining the same from pre to post intervention phases. This next section will describe changes in reading development and processing strengths and weaknesses in relation to the relevant models.

Table 18. Comparison of Child B's performance on the ESSI Reading and Spelling Test (Esterhuyse & Beukes, 1997).

SUBTEST	Pre-intervention		Post-intervention	
	PERCENTILE RANK*	INTERPRETATION	PERCENTILE RANK*	INTERPRETATION
Reading of sight words	60	Average	60	Average
Spelling of single words	60	Average	60	Average

Table 19. Comparison on Child B's performance on the Neale Analysis of Reading Ability 2nd Revised Edition (Neale, 1997).

SUBTEST	Pre-intervention		Post-intervention	
	PERCENTILE RANK*	INTERPRETATION	PERCENTILE RANK*	INTERPRETATION
Accuracy	4	Significantly below average	12	Below average
Comprehension	13	Below average	14	Below average
Rate	<4	Significantly below average	9	Below average

4.4.5.2. Developmental and information processing models:

Child B remained at Ehri's full alphabetic phase and Chall's second phase at post intervention. Although her accuracy and rate of reading passages improved slightly, her scores were still in the below average range in comparison to her peers. Her sight word reading and reading comprehension remained unchanged.

Ellis and Young's model was useful for describing Child B's processing of spoken words, particularly in view of her second language learning. However it was less useful in describing her reading of longer texts because it only considered processing at the single word level. Child B's reading difficulties were evident at the sentence/connected text level when reading passages (as tested by the Neale Analysis of Reading Ability Second Revised Edition (Neale, 1997)) and these could not be described using Ellis and Young's model. As mentioned previously, difficulties reading longer, connected text are often related to problems with text integration and higher level cognitive skills (i.e. working memory) (Norton &

Wolf, 2012; Oakhill et al., 2003; Wolf, 2008). Therefore these skills may have contributed to her weaknesses in reading comprehension and accuracy of longer texts.

In this model, Child B's pre intervention weaknesses were mostly related to processing of spoken language because of second language learning. As no standardized spoken language assessments were conducted in the post intervention phase, it is not possible to comment on any improvement related to processing of spoken words. Child B's teacher reported a noticeable improvement in her oral language communication and literacy skills in the classroom.

4.4.6 Child summary:

Child B was a grade one second language learner whose main areas of difficulty were language related and included difficulties with receptive and expressive oral language as well as reading comprehension and accuracy of written language. Her poor scores on spoken and written language measures seemed to be related to second language learning. In terms of the intervention, Child B received a total of six and a half hours of app-based reading therapy at both the single word and phrase reading levels. She experienced positive outcomes from the intervention, which included an improvement in reading the items treated in the intervention. Her reading accuracy and rate of passages also improved on standardized measures, however these remained in the below average range compared to her peers.

4.5. CHILD F:

4.5.1. Background information:

At the start of the study, Child F was a 7; 10 year old learner in grade two at a mainstream government school. Her birth history, developmental milestones and medical history were normal. Her mother reported a family history of learning difficulties as she herself struggled with reading and writing as a child.

When Child F was in grade R her parents and teacher became concerned about her word finding difficulties, difficulty learning colours and shapes (she still struggles with the latter), noise and taste sensitivity, fluctuating performance from day to day, as well as irregularities in social interactions (playing alongside rather than with friends). She was referred to an SLT in order to address her word finding difficulties. The speech and language assessment confirmed the word finding difficulties and also revealed difficulties with articulation (production of /f/ for “th”), comprehension of complex sentences, co-ordination and sub-ordination in discourse, use of pronouns, past tense forms, irregular plurals, narrative style and comparatives and superlatives.

Child F was then referred to a Paediatric Neurologist and Clinical Psychologist in order to determine whether her expressive language difficulties were an isolated problem or part of a greater learning difficulty. Neuropsychological testing found that her overall IQ was in the above average range. Her performance IQ was exceptionally high (in the superior range) and she excelled at all tasks that were visually presented, “hands on” activities and demonstrated excellent logical reasoning and problem solving skills. However her verbal IQ was significantly lower, despite still being in the average range. This discrepancy between verbal and non-verbal IQ indicated a specific learning disability. It was then recommended that she continue to receive private SLT and progress to a mainstream grade one class with remedial support where necessary. SLT sessions continued to focus on improving word retrieval skills, auditory manipulation of phonemes, as well improving use of irregular morphology and verbal and written narratives. Child F made good progress in the SLT sessions, which continued throughout the duration of the study. Child F has a LeapPad at home that she uses for sight word practice.

4.5.2. Pre intervention findings:

4.5.2.1. Summary of assessment findings:

The full battery of assessments in Appendix E was used to evaluate Child F's language comprehension and expression, auditory perceptual skills, phonological awareness, literacy and speech production. For detailed assessment results for each assessment, please refer to Appendix K

These assessments were administered over five sessions, each session ranging from 60 – 120 minutes. The assessments were conducted over a number of shorter sessions in order to reduce fatigue. A short game was used after every few assessment tasks as a form of reinforcement.

Child F's performance in the formal language assessments were within the average range, and she excelled at working memory tasks. However, word finding and narrative difficulties were clearly evident in spontaneous conversation, and these were an obvious source of frustration for her. Her auditory perceptual skills, reading of sight words and spelling of single words were all typical for a child of her age. It should be noted that although F's sight word reading was found to be within normal limits for her age as tested by the ESSi Reading and Spelling Test (Esterhuyse & Beukes, 1997), this assessment only evaluated sight word reading at the single word level.

Some difficulties were identified with Child F's phonological awareness. These included difficulties with rhyme discrimination, segmentation and blending of syllables and reading of 'magic-e' words. Child F's strengths in the other areas of phonological awareness compensated for these difficulties, which resulted in an overall PAT 2 score within the average range. The assessment of reading accuracy and comprehension of passages showed that her overall understanding of a written story was in the normal range. Her reading accuracy was on the lower end of the average range; however her reading rate was also slower compared to her peers. During the administration of the Neale Analysis of Reading Ability Second Revised Edition (Neale, 1997), it was observed that Child F had to sound out many of the words when reading passages. Therefore she struggled to read words by sight in longer texts. As a result of sounding out

many of the words, her reading was often slow and laborious, particularly when reading longer passages (as tested by her below average reading rate in the Neale Analysis of Reading Ability Second Revised Edition (Neale, 1997)). This is suggestive of some difficulties with sight word reading. Overall her reading of sight words at the single word level was found to be age appropriate (as tested by the ESSI Reading and Spelling Test (Esterhuyse & Beukes, 1997)), however she struggled to read words by sight in longer texts (as seen in the Neale Analysis of Reading Ability Second Revised Edition (Neale, 1997)), which resulted in an increased rate of reading. In view of the above, Child F was at risk for experiencing reading difficulties, particularly when reading demands in the classroom increase. In terms of her speech production, she substituted the speech sound 'th' for /f/ in all word positions.

4.5.2.2. Developmental and information processing models:

In terms of her reading development at the start of the study, Child F was at Ehri's (1995) full alphabetic phase and Chall's (1967, 1996) second phase of reading development. This was evidenced by her knowledge of alphabetic principles and grapheme-phoneme correspondence rules, which she used to decode words. As a result of sounding out many of the words, her reading was often slow and laborious, particularly when reading longer passages (as tested by her below average reading rate in the Neale Analysis of Reading Ability Second Revised Edition (Neale, 1997)). This is suggestive of some difficulties with sight word reading in connected texts. Although her reading of sight words at the single word level was found to be age appropriate (as tested by the ESSI Reading and Spelling Test (Esterhuyse & Beukes, 1997)), she struggled to read words by sight in longer texts (as seen in the Neale Analysis of Reading Ability Second Revised Edition (Neale, 1997)), resulting in an increased rate of reading.

According to Bishop and Snowling's (2004) adaptation of the Simple View of Reading model, Child F would fit into quadrant D ('poor comprehender'). The rationale for this is that although she has adequate decoding skills at the single word level (as tested by the ESSI Reading and Spelling Test (Esterhuyse & Beukes, 1997)), she struggled with language related word-finding difficulties. In

addition, her reading accuracy and comprehension of passages was in the low average range, with rate of reading in the below average range. This puts her at risk for reading problems.

Now that Child F's reading development and reader profile has been considered, her processing of spoken and written words can be described. In terms of Ellis and Young's processing model of spoken and written words, Child F had a number of strengths and weaknesses. Strengths included:

- Adequate semantic system as evidenced by her receptive vocabulary
- An appropriate visual analysis system as tested by visual identification of graphemes and words.
- A largely effective grapheme-phoneme conversion system as evidenced by her ability to correctly identify grapheme-phoneme correspondence and sound out (segment and blend) the phonemes of words for decoding.

Child F's processing profile also contained some weaknesses, which were as follows:

- A potentially poor speech output lexicon as evidenced by her word-finding difficulties in conversational interactions.
- A struggling visual input lexicon, as evidenced by difficulties reading words by sight in longer texts/passages.
- Some difficulty at the phoneme level as evidenced by her difficulty producing the 'th' speech sound.

4.5.3. Intervention:

Child F had a total of two hours and 40 minutes of app-based reading intervention. This time was equally divided into intervention at the phrase level and intervention at the sentence level. She progressed to the sentence level when she was able to maintain 90% or more correct responses consecutively for two sessions. The individual sessions ranged from 20 to 30 minutes in length and were conducted in a quiet room during the school day. The reason why she

had a shorter period of intervention was because she reached ceiling level more quickly than the other participants.

The Fidelity Checklist was conducted before and after every session in order to ensure consistency and to document any important information relating to iPad® usage, the environment and her behaviour. Sessions were conducted in a quiet room at the school during the school day. At times, other children worked in the room, however noise levels were always low and there was little disturbance. Child F was generally co-operative during the sessions. However at times she struggled to maintain her attention and focus on the reading tasks at hand. This may have been because she did not find the tasks challenging or engaging enough, as evidenced by the fact that she reached ceiling level early on during the intervention phase.

The next section will explain Child F's performance on treated and untreated probe items and how these can be used to document post intervention changes in reading.

4.5.4. Treated and untreated probe items:

Figure 15 (a and b) and Tables 20 and 21 depict changes from the time of initial assessment (t1), baseline/control period (t2) to post intervention (t3) for treated (List A) and untreated (List B) probe items at the phrase and sentence reading levels. The percentage refers to the percentage of items that Child F scored correctly in probe assessments of treated (List A) and untreated (List B) items.

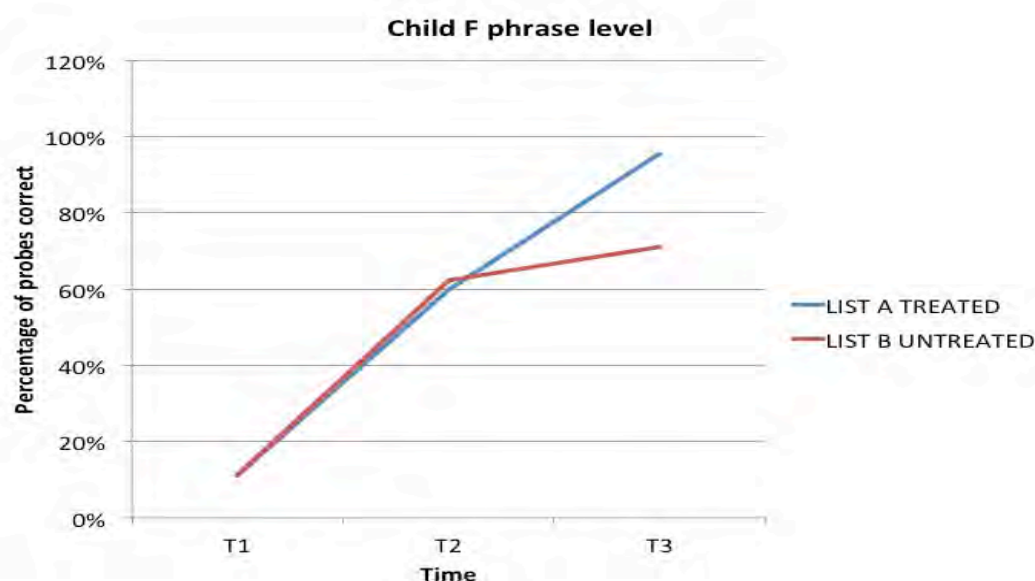


Figure 15a. Child F's changes over time for treated (List A) and untreated (List B) probe items at the phrase reading level.

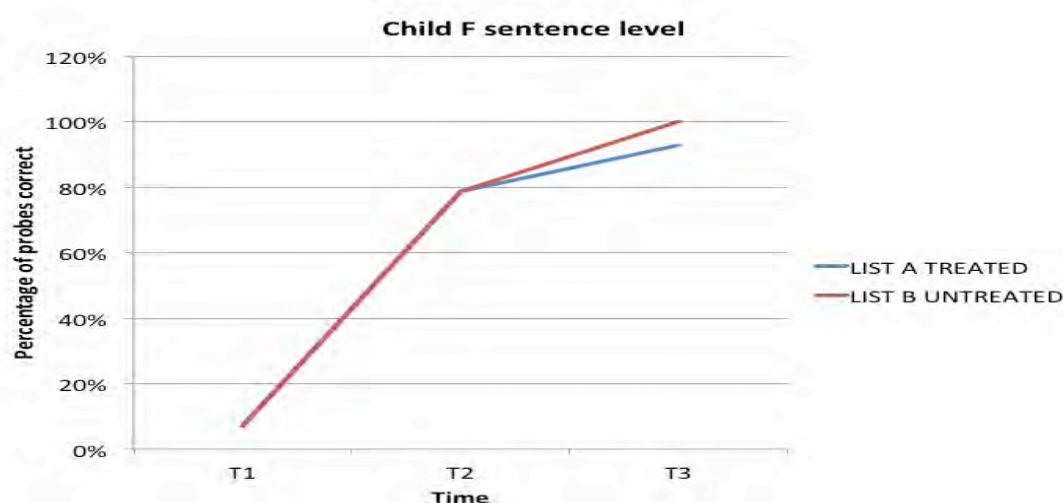


Figure 15b. Child F's changes over time for treated (List A) and untreated (List B) probe items at the sentence reading level.

Both graphs show an increasing trend in the data as time progressed. There was also an upward trend in the baseline control period from t1 to t2. Child F's performance on the treated and untreated probe items increased equally at t1 and t2. At the phrase level, the treated lists improved significantly more than the untreated lists from t2 to t3, suggesting that the intervention was successful at improving her reading of treated words. At the sentence level however, the improvement at t3 was not significant (see Table 21).

Table 20. Comparison over time for Child F's treated and untreated, matched phrases.

TIME	LIST A - TREATED	LIST B - UNTREATED
T1 (initial)	5/45 (11%)	5/45 (11%)
T2 (pre intervention)	27/45 (60%)	28/45 (62%)
T3 (post intervention)	43/45 (96%)	32/45 (71%)

Table 21. Comparison over time for Child F's treated and untreated, matched sentences.

TIME	LIST A - TREATED	LIST B - UNTREATED
T1 (initial)	1/14 (7%)	1/14 (7%)
T2 (pre intervention)	11/14 (79%)	11/14 (79%)
T3 (post intervention)	13/14 (93%)	14/14 (100%)

As with the other participants, t-tests were conducted in order to determine whether the improvement across time (i.e. from t1, t2 to t3) and across lists (treated List A and untreated list B) was statistically significant. At t1 and t2, both lists were equally matched for both reading levels. Comparison across time on list A showed that the improvement from t1 to t2 was statistically significant at the phrase ($t(44)=6.4874$, $p < 0.0001$) and sentence ($t(13)=5.7009$, $p < 0.0001$) levels. This was also the case for list B, where the difference from t1 to t2 at phrase level was $t(44)=6.7823$, $p < 0.0001$ and at the sentence level was $t(13)=5.7009$, $p < 0.0001$.

When examining the improvement from t2 to t3, analysis revealed that there was only significant improvement at the phrase word level. At this level, there was significant improvement from t2 to t3 on list A and list B ($t(44)=4.9271$, $p < 0.0001$; $t(44)=2.0719$, $p=0.0442$ respectively) but not at the sentence level.

The most important finding here was at t3, where Child F's performance on treated and untreated lists was compared. At the phrase level she performed significantly better on treated items than untreated items ($t(44)=3.7859$, $p=0.0005$); however there was no significant difference at the sentence level. Therefore, Child F responded better to intervention at the phrase level compared to the sentence level.

4.5.5. Post intervention outcomes:

4.5.5.1. Post intervention literacy measures:

On re-evaluation of sight word reading and spelling of single words using the ESSI Reading and Spelling test (Esterhuyse & Beukes, 1997), Child F's score remained unchanged from pre to post intervention (see Table 22 and Appendix K).

As seen in Table 23, reading accuracy and comprehension of passages also remained in a similar range from pre to post intervention, as tested by the Neale Analysis of Reading Ability Second Revised Edition (Neale, 1997) – both subtests remained in the average range. There was a significant improvement in reading rate of passages, which improved from the below average range at pre intervention (13th percentile), to the average range at post intervention (23rd percentile). This improvement with reading rate may be reflective of an improvement in sight word reading in longer texts.

Although all of her scores on the Neale Analysis of Reading Ability Second Revised Edition (Neale, 1997) were in the average range at post intervention, they were all in the lower average range, which suggests that she may still be at risk for later reading problems, particularly as literacy demands in the classroom environment increase.

Table 22. Comparison of Child F's performance on the ESSI Reading and Spelling Test (Esterhuysen & Beukes, 1997).

SUBTEST	Pre-intervention		Post-intervention	
	PERCENTILE RANK*	INTERPRETATION	PERCENTILE RANK*	INTERPRETATION
Reading of sight words	60	Average	60	Average
Spelling of single words	60	Average	77	Average

Table 23. Comparison of Child F's performance on the Neale Analysis of Reading Ability 2nd Revised Edition (Neale, 1997).

SUBTEST	Pre-intervention		Post-intervention	
	PERCENTILE RANK*	INTERPRETATION	PERCENTILE RANK*	INTERPRETATION
Accuracy	18	Average	24	Average
Comprehension	26	Average	22	Average
Rate	13	Below average	24	Average

4.5.5.2. Developmental and information processing models:

In terms of Child F's reading development at the post intervention phase, it was hypothesized that she was entering Frith's consolidated alphabetic phase and Chall's third phase of reading development. This was evidenced by her improved reading rate and fluency in the Neale Analysis of Reading Ability Second Revised Edition (Neale, 1997) as well as use of more developed decoding strategies (i.e. breaking words down in to segments/onset/rimes, as opposed to its individual letters). An improvement with sight word reading in passages may have also contributed to an improved reading rate in the Neale Analysis of Reading Ability Second Revised Edition (Neale, 1997). Therefore from pre to post intervention, Child F's reading progressed to the next phase of development, as evidenced by the relevant developmental models above.

According to Ellis and Young's model, Child F's visual input lexicon may have developed from pre to post intervention. At the pre intervention phase, her visual input lexicon was identified as a weakness in her processing profile because she struggled to read words by sight in longer texts, which resulted in slower, more laborious reading. Her reading fluency improved at post intervention, as evidenced by her reduced rate of reading in standardized literacy measures. If this improvement in reading rate was caused by an

improvement in sight word reading of passages, it suggests that her visual input lexicon improved, as this mechanism is largely responsible for processing of sight words.

4.5.6. Child summary:

Child F was a grade two learner at the time of the study. Her family and teachers became concerned about learning and behavioural issues, most notably her word finding difficulties. Neuropsychological testing revealed an above average IQ, however because of the discrepancy between her non-verbal and verbal IQ score, she was diagnosed with a specific learning disability. In the initial assessments of the study, Child F's performance in the formal language tests was generally within the average range, and she excelled at working memory tasks. However, word finding and narrative difficulties were clearly evident in spontaneous conversation, and these were an obvious source of frustration for her. In terms of her reading, an increased rate for reading of passages was noted, which was likely related to a limited sight word inventory with connected texts. After a baseline control period she received two hours and forty minutes of app based reading intervention. She started at the phrase level and quickly progressed to the sentence level. She responded positively to the intervention, as evidenced by her improvement on treated items at the phrase level. Although most of the standardized literacy measures remained fairly stable from pre to post intervention, Child F's reading rate improved from below average range to the average range when compared to her peers. This improvement in reading fluency may have been caused by improved sight word reading or the use of more developed decoding strategies. Finally, her overall level of reading development also improved from pre to post intervention (Chall, 1967, 1996; Ehri, 1995).

4.6. CHILD E:

4.6.1. Background information:

Child E was 8; 10 years at the start of the study. She was diagnosed with Down's Syndrome at birth and experienced speech, language and feeding difficulties related to this. At the time of the study she was in a mainstream grade two class in a government school, with a full-time private facilitator. Although she was in a grade two class, her parents and facilitator described her reading level as that of a grade one learner.

All of Child E's developmental milestones were significantly delayed. In terms of speech development, she spoke her first words around 4-5 years of age with poor speech intelligibility. Her language development was characterized by a limited vocabulary, short utterances and incomplete sentences. She had a history of recurrent ear infections and had grommets inserted on three occasions. From infancy, Child E struggled with feeding and swallowing (she struggled to breastfeed). However her mother has reported that this has improved with age. She still experiences some minor feeding and swallowing difficulties (e.g. sometimes she had difficulty chewing some foods and coughs occasionally when eating/drinking), however these are well controlled. Child E is the eldest of two siblings – a brother of seven and a sister of three years of age.

Child E attended SLT at a local children's hospital when she was a younger child, and again more recently at a private practice for a period from 2011 – 2012. Therapy focused on improving language skills, speech intelligibility and pre-literacy skills. She made some improvements in all of the above-mentioned areas and mainstream schooling with maximum educational support was recommended.

At the time of the study, Child E's teacher and educator were most concerned about her difficulty blending sounds together when reading words, resulting in generalized reading difficulties.

4.6.2. Pre intervention findings:

4.6.2.1. Summary of assessment findings:

Assessment tasks were broken up over a number of shorter intervals in order to account for Child E's reduced attention span, which was approximately 30 minutes long. Simple games were used as reinforcers for positive behaviours and short breaks were provided between assessment tasks.

Her understanding and use of language was assessed using subtests of the Reynell Developmental Language Scales (3rd ed.) (Edwards et al., 1997). The administration and interpretation of her results was qualitative in nature, which allowed for description of her strengths and weaknesses (see Appendix L). In summary, Child E was able to comprehend and use basic language forms and structure. This included a vocabulary of simple nouns, prepositions, adjectives and verbs. She was able to comprehend short sentences and instructions with no more than two information-carrying parts, however she struggled as the length and linguistic complexity of stimuli increased.

In terms of her phonological awareness skills, her knowledge of letter-sound correspondences was fair, however she struggled to blend and segment the sounds and syllables in words. Her segmentation skills improved with written cues, however she struggled to perform this task purely using sounds. Child E responds better to visual stimuli as opposed to auditory stimuli.

Child E's reading of single words and sight words was also assessed qualitatively (See Appendix L). Although she was able to segment the letters into the relevant sounds, she struggled to blend them together to form a word. Her facilitator confirmed this, and reported that difficulties with blending letters was one of Child E's main problems when reading. In addition, sight word reading was found to be inconsistent. Child E was able to spell her name correctly and was able to write some letters accurately (see Appendix L), however she was unable to spell simple words (e.g. cat, hot).

Child E's speech was characterized by patterns typical in children with Down's syndrome. This included imprecise articulation, a horse voice and ultimately poor speech intelligibility.

4.6.2.2. Developmental and information processing models:

In reference to Child E's reading development in the pre intervention phase, she was in Ehri's partial alphabetic phase and Chall's second phase. She was still in the process of developing some letter-sound correspondences, but not all. She was also unable to segment all of the phonemes in words, particularly longer words with consonant clusters. However, she had learnt some sight words and word recognition skills. Her reader profile fit the criteria of quadrant D ('poor comprehender') as she experienced both phonological and non-phonological reading difficulties (Bishop & Snowling, 2004).

Child E's processing of spoken and written words contained a number of strengths and weaknesses. These will be discussed in accordance with Ellis and Young's (1988, 2002) information processing model. In relation to this model, her profile contained the following strengths:

- An adequate visual analysis system as evidenced by her positive response to visual letter stimuli in auditory tasks.
- Fair grapheme-phoneme conversion system as evidenced by her knowledge of grapheme-phoneme correspondence rules.

Her processing profile also contained some weaknesses, which were as follows:

- A poor semantic system as tested by her understanding and use of vocabulary, which was found to be limited to basic parts of speech. She struggled with more complex vocabulary, particularly in longer phrases and sentences
- A limited speech output lexicon and speech production system, as indicated by her poor pronunciation of familiar words.

4.6.3. Intervention:

Child E had a total of three and a half hours of intervention at the single word reading level only. Sessions lasted approximately 20 minutes in order to accommodate her attention span.

The Fidelity Checklist was conducted before and after every session in order to ensure consistency and to document any important information relating to iPad® usage, the environment and her behaviour. Sessions were conducted in a quiet room during the school day. At times, other children worked in the room, however noise levels were always low and there was little disturbance. Child E was generally co-operative and participated appropriately during the sessions. However, when sessions were conducted later in the day (i.e. after first break), she was more distracted and had difficulty concentrating. This may have been caused by fatigue as the school day progressed, or that she had difficulty settling down to work after break.

4.6.4. Treated and untreated probes:

Figure 16 and Table 24 depict changes from the time of initial assessment (t1), baseline/control period (t2) to post intervention (t3) for treated (List A) and untreated (List B) probe items at the single word reading levels. The percentage refers to the percentage of items that Child E scored correctly in probe assessments of treated (List A) and untreated (List B) items.

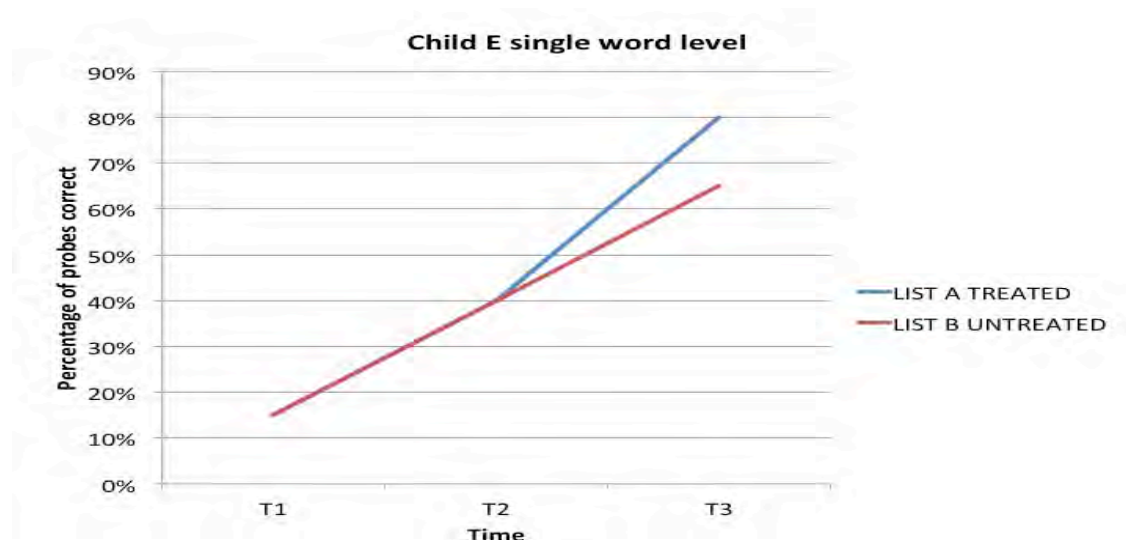


Figure 16. Child E's changes over time for treated (List A) and untreated (List B) probe items at the single word reading level.

There was an increasing trend in the data as time progressed. There was also variability of the data across time, resulting in an unstable pre intervention baseline from t1 to t2. Child E's performance on the treated and untreated probe items increased equally at t1 and t2. From t2 to t3, the treated list improved somewhat more than the untreated list.

Table 24. Comparison over time for Child E's treated and untreated, matched single word items.

TIME	LIST A - TREATED	LIST B - UNTREATED
T1 (initial)	3/20 (15%)	3/20 (15%)
T2 (pre intervention)	8/20 (40%)	8/20 (40%)
T3 (post intervention)	16/20 (80%)	13/20 (65%)

Results indicate that Child E's performance was equal / equivalent at t1 on both list A and list B, suggesting that the lists were well-matched. From t1 to t2 there was a significant improvement on list A ($t(19)=2.5166$, $p=0.0210$) and list B ($t(19)=2.5166$, $p=0.0210$). This was also the case from t2 to t3, where list A ($t(19)=3.5590$, $p=0.0021$) and list B ($t(19)=2.5166$, $p=0.0210$) improved significantly. The difference between treated and untreated lists at t3 was not statistically significant.

Some observations were also made by the researcher during the intervention sessions. These included improved blending and decoding by approximately the

eighth session, as well as improved speed of reading and word recognition by approximately the tenth session. Child E's facilitator reported that her blending skills and sight word reading had improved since starting the intervention.

4.6.5. Post intervention outcomes:

4.6.5.1. Post intervention literacy measures:

Due to time constraints and Child E's limited attention span, only the qualitative phonological awareness assessment (based on the Phonological Awareness Test 2 (PAT 2) by Robertson and Salter (2007)) was conducted post intervention. These findings are detailed in Appendix L. In summary, Child E made some improvement in segmentation and blending of syllables and phonemes, as well as rhyme production. This improvement with blending is particularly significant as Child E's facilitator identified blending difficulties as one of the main causes of her reading problems.

4.6.5.2. Developmental and information processing models:

In terms of Child E's reading development, it is likely that this remained unchanged in the post intervention phase. This is evidenced by her level of phonological awareness and grapheme-phoneme knowledge. Therefore she was still at Ehri's partial alphabetic phase and Chall's second phase of reading development. Unfortunately it is not possible to comment on her post intervention processing profile (Ellis & Young, 1988, 2002) as further language and reading measures were not conducted due to procedural time constraints.

4.6.6. Child summary:

Child E was an 8; 10 year old grade two learner, who was diagnosed with Down's syndrome at birth. At the time of the study she was in a mainstream grade two class with a full-time private facilitator. Assessments were based on standardized tests however these were conducted and evaluated qualitatively in order to best describe her strengths and weaknesses. E's language, phonological awareness and literacy skills were all markedly delayed. In terms of her reading, she had particular difficulty blending sounds to read words and had a limited

sight word inventory. Child E received a total of three and a half hours of app-based reading intervention at the single word level. Sessions were kept short in order to maximize her attention and concentration. In terms of the results of intervention, there was significant improvement over time. However the difference between her performance on treated versus untreated items at t3 was not statistically significant. Positive outcomes were evident in the post intervention assessment where there was improvement with phonological awareness skills, such as blending and segmentation. In terms of her overall reading development, this remained unchanged from pre to post intervention.

This next section will detail the information obtained from the child interviews and will be followed by a summary of the chapter.

4.7. CHILD INTERVIEWS:

The purpose of the qualitative child interviews was to describe each child's experience of the intervention. This section will summarize the responses from the child interviews and highlight the common themes and differences among them.

The child interview schedule consisted of four main questions, with 'prompt' questions designed for each one (see Appendix M). The interviews were all conducted post intervention in a quiet room at the child's school. Interviews were audio recorded for later transcription however nonverbal responses were noted by the researcher where appropriate. For example, sometimes Child E nodded (nonverbal) in response to a question, as opposed to providing a verbal response. This was noted in her interview transcript (see Appendix N). Once the interviews were transcribed, common themes and differences in responses were analyzed. The questions and common themes from the child responses are summarized in Table 25.

Table 25. Summary of qualitative interviews regarding the children’s experiences of the intervention.

INTERVIEW QUESTIONS	THEMES	EXAMPLES
What did you enjoy about the activities?	Working on the iPad®.	Child G: “And the iPad makes you more learn and its so nice because you always want to stay there...” Child B: “The iPad...because it had a lot of reading” Child E: “To click on words.”
What did you not enjoy about it?	Making mistakes. Nothing.	Child G: “When I get it wrong.” Child B: “No”
What could we do to make the activities better?	Different levels/making it more challenging	Child F: “A bit more harder.”
Do you like to read?	Yes.	Child G: “Yes, so much” Child S: “Ya” Child E: “Yes”

In response to the first question, all children reported positive statements about the intervention. These positive statements all related to working on the iPad®. Their reasons for enjoying working on the iPad® differed somewhat and included the following: it was “fun”; it improved/maximized their learning (“...the iPad make you learn more”); it was easy to use (in reference to the selection of items by “clicking” on the stimuli); and because of the focus on reading. Aspects they did not like about the intervention was when they made mistakes while reading. Other children reported that there was nothing that they did not like. Child F in particular reported that the intervention may have been too easy and that she would have enjoyed it more had the level been more challenging. Child E reported that she did not like being helped when working on the iPad® and enjoyed being able to work independently.

The children’s feedback from the intervention included making the intervention more challenging and having increasing levels of difficulty for children of different grades. Child S suggested including a point system with rewards, which may improve child motivation.

Finally, all children responded positively to the question about reading. When asked to explain why reading is important for children, some of them related it to learning in general (e.g. “Because sometimes when its make you learn and when

you”; “Because then you learn new words... then you know what the words mean”). When asked whether it was easy or difficult for them to read, most of children reported that reading was easy for them, with Child E reporting that it was easier to read on the iPad® because she could manually select the words by clicking on them.

4.8. SUMMARY OF CHAPTER:

This chapter has described the findings for each of the five child participants in the pre intervention, intervention and post intervention phases.

Each child was described individually in their own section of this chapter, starting with an account of their background information, followed by pre intervention assessment findings. Their level of reading development was described in accordance with developmental models by Chall (1967, 1996) and Ehri (1995). Their reader profile was also described using Bishop and Snowling’s adaptation of the Simple View of Reading model (2004). This was followed by a description of each child’s strengths and weaknesses of processing spoken and written words by considering the information processing model of Ellis and Young (1988, 2002). This model was useful in describing the processing skills of some participants, but not all. This was because the model only considered processing at the single word level, and was therefore unable to fully capture processing difficulties at the sentence or conversational levels.

This was followed by a description of the intervention that each child received as well as their performance on treated and untreated probe items at different times throughout the study. A stable baseline was not achieved for any of the participants, which was likely due to their fast rate of maturation and the heavy focus on literacy in the classroom. Despite this, all of the participants had improved reading on items treated in the intervention. Post intervention literacy measures were then conducted to document any generalization that occurred. Some of the participants’ post intervention reading and spelling score improved significantly from pre to post intervention testing. The participants’ reading development and processing was described again after the intervention in accordance with the relevant models described above. In this way, any

changes within the bigger picture of their overall development and processing could be documented.

Finally, this chapter concluded with a summary of the child interview responses, which described common themes and differences among their responses. All of the children reported positive experiences related to the intervention, particularly with regards to and working on the iPad®. This thesis will conclude with a final Discussion Chapter in which the implications of the study's findings will be discussed.

CHAPTER FIVE: DISCUSSION

5.1. INTRODUCTION TO CHAPTER:

The final chapter of this dissertation will discuss the main findings and implications of the app-based intervention for reading using a single subject design. In Chapter Four, findings showed that the app-based intervention was effective in bringing about changes in each of the children's reading abilities. All of the children improved in their ability to read and comprehend written stimuli that were used in the intervention itself, and with the matched control stimuli. For some, but not all of the children, the ability to read improved in relation to that of typically developing peers suggesting that the children had improved their reading beyond what would be expected over the course of a school year and due to maturation effects. The benefits of the intervention varied from child to child, and the intervention design itself raised some challenges for the researcher. This chapter has discussion of these issues as its focus.

The study makes two main contributions to the field. Firstly, it contributes by relating findings to current literature on reading intervention and theories about reading. Secondly, it contributes in an applied sense by suggesting clinical and educational implications for SLTs and teachers working with children with reading difficulties.

Findings of the study were presented in the previous chapter by considering each child as an individual, detailed case. In this chapter, I start by considering the main outcomes of the intervention by looking across all participants. The discussion focuses on the participants' characteristics, reading difficulties as well as their post intervention scores and generalization. Relevant themes from the child interviews will also be selected and related to the current literature on the use of technology and tablets/iPads® in intervention. The functional application of developmental and information processing models will also be discussed. Consideration will be given to their clinical application in assessment and therapy by discussing the benefits and limitations in the clinical settings.

Literature on reading intervention, introduced in Chapter One, is returned to in this chapter. The contributions of the present study to this literature are considered and related to the South African educational situation, which was also introduced in the opening chapters of the project. The discussion details specific ways in which SLTs, teachers and learners can collaborate in order to support and address learner development of spoken and written language with the use of tablet technology. Reference will also be made to how SLTs can advocate for app-based reading intervention at higher levels of education and government. Following from this, general clinical implications, limitations and suggestions for future research will be discussed.

5.2. MAIN OUTCOMES OF THE STUDY:

This section will draw together common themes and differences arising from the study. First, relevant participant characteristics will be discussed, after which the participants' language and reading related difficulties will be considered. Then, the main outcomes of the intervention will be summarized and generalization will be discussed. This study has contributed to the knowledge base on the process and outcomes of app-based interventions using tablets/technology, with five individual children who presented with different profiles and difficulties.

The children participating in the study differed in a number of ways. Two of the children were first language speakers of languages other than English (Child G – French, and B - Setswana), and struggling with learning to read in English. One of the children had Down's syndrome, one was typically developing, while the other had a specific learning difficulty. What the children shared was that they were experiencing reading difficulties - all were categorized as 'poor comprehenders' according to Bishop and Snowling's (2004) reader profile model. In addition, their ages (7; 1 to 8; 10 at the start of the study), grades (grades one and two at the start of the study) and geographical location were similar. In terms of gender, there were four girls and one boy. A single subject design such as this one allows for participants to be similar in some ways and very different in other ways. Knowing that an intervention for a specific difficulty – in this case reading -

works for a wide range of different children, strengthens the case for the intervention. This has practical implications for clinicians who need to use their interventions with a range of different children. However, there are sequential and systematic phases that need to be followed when evaluating the outcomes of an intervention (Robey & Schultz, 1998). As described in Chapter One, Robey and Schultz (1998) recommended that a five phase health care model be used in order to guide clinical outcomes research. The five phases were as follows:

- Phase I: Develop a hypothesis for an intervention
- Phase II: Evaluate the efficacy (Intervention outcomes in an optimal or 'perfect' situation) of the intervention
- Phase III: Test the effectiveness (intervention outcomes in a realistic, practical, real world situation)
- Phase IV: Initial testing of efficiency (cost effectiveness and time effectiveness of the intervention)
- Phase V: Continuation of efficiency testing in terms of cost effectiveness and time effectiveness.

This study followed the first two phases of Robey and Schultz's model, which was appropriate considering the exploratory stages of this intervention research. A single subject efficacy study such as this one, is an important part of intervention outcomes research because it allows the researcher to develop a strong foundation upon which further hypotheses can be developed and from which a larger more extensive evaluation can be carried out (Pascoe et al., 2006; Robey & Schultz, 1998). Therefore this study lays the foundation and groundwork for further research of the effectiveness and efficiency of this intervention. This will be discussed further later on in this chapter

With the broad participant characteristics already considered, the discussion will progress to the participants' language, reading and general learning profiles, and will begin by considering the second language learners. Both second language participants responded positively to the intervention in a number of ways. Firstly, their reading of the items treated in the intervention improved

significantly over time. At the end of the intervention, there was also a significant difference between treated and untreated items, suggesting that the improvement on treated items was due to the intervention itself. Untreated matched items had improved, indicating generalization effects, but not to the extent of the treated items. Both of these children also improved in terms of the standardized assessments, which compared their performance to their typically developing peers, further supporting the notion of generalization to a wider set of items beyond the treated set. Additional positive outcomes were apparent in the qualitative child interviews, as both of these children responded positively to questions about the intervention and enjoyed working on the iPad®.

For the second language learners, it is likely that the relatively high dosage of intervention, which provided them with intensive 1:1 exposure to English in its oral and written forms, was a contributing factor to the successful outcomes that they experienced. The tablet form is especially useful for increasing dosage and exposure to the target skill/behaviour. Along with tablets providing an interactive and motivating vehicle for children's learning, one of its most important benefits is the opportunity for increasing dosage and independence for learning (Wolf, Ullman-Shade, Gottwald, 2012). This is particularly relevant in developing countries where teachers and health professionals are often overburdened and understaffed. If these children received a higher intensity of intervention, together with having access to the tablet at home, it is possible that their reading would have made even greater improvements and generalizations to other skills. For children who are learning in a second language and provided they have no specific underlying learning or medical issue, exposure is what they need. This most likely the reason why Child G and B made the gains they did in therapy.

Child G and B were also different, despite the fact that both were second language learners. Although both children responded favourably to the intervention, and were at similar levels of reading development, their performance on pre and post intervention literacy measures differed somewhat. For example, both of these children struggled with standardized language

assessments in the pre intervention phase, however Child G performed more poorly on these tests than Child B. They also differed in the pre intervention literacy measures, where Child B performed better with single word reading and spelling compared to Child G, whereas Child G performed better in the assessments that contained connected text. However, Child G's improvement on post intervention standardized measures was relatively greater than Child B's improvement – perhaps because Child G had greater difficulties than Child B, Child G had further to change. These differences suggest that one cannot assume that all second language learners have the same linguistic profile and experience the same difficulties; and as a result a 'one size fits all' approach to intervention cannot be applied to all second language learners. The level and integrity of Child G and Child B's skills in their first language should also be considered. An important consideration is to determine whether these language and reading difficulties were related purely to second language learning, or perhaps whether language learning difficulties were also present in the children's first language. In order to make this differential diagnosis, a thorough case history of developmental language milestones and in-depth language assessments in the child's first language are required. In the case of Child B and Child G, both caregivers reported normal early language milestones. Due to time restrictions and lack of standardized language and literacy measures in the children's first languages, this was not feasible. Nevertheless, because Child G performed comparatively poorer on language and literacy measures, it is necessary to consider the potential presence of an additional learning difficulty. This difficulty in making a differential diagnosis in second language learners is an everyday challenge experienced by SLTs throughout South Africa, and is exacerbated by a lack of multilingual SLT graduates as well as a lack of standardized assessment materials in other languages.

Although there have been some recent studies evaluating the use of app based intervention for children with developmental disorders, such as Autism and Cerebral Palsy (see King et al., 2014; Pinto & Gardner, 2014), there appeared to be a dearth of literature on app based interventions for school aged second language learners. Therefore this study makes a much-needed contribution to

the literature with regards to the process and outcomes of app based interventions for second language learners.

Returning to the study's participants, Child E and Child F both experienced problems with delayed language development, however the nature of their language difficulties/delay was vastly different. Child F was diagnosed with a specific learning difficulty and experienced word-finding difficulties in conversation. Child E was diagnosed with Down's syndrome from birth and therefore experienced the language, speech and cognitive difficulties associated with this developmental disorder.

For Child E, there was an improvement in her reading across time, from initial assessment to post intervention, for both treated and untreated lists. However at the end of intervention, there was not a significant difference between treated and untreated lists. This suggests that although there was a pre to post intervention improvement, it appeared to be for both lists, whether treated or untreated. These outcomes may show that her memory of the items treated in the intervention was poor, however the intervention process taught her to acquire new decoding skills, which she could apply to the untreated lists. In addition to this, other positive outcomes emerged from Child E's intervention. For example, her facilitator reported an improvement in her blending and sight-word reading skills. This was confirmed by the researcher, who observed an improvement in E's blending skills by the eighth session and an improvement in speed of reading/word recognition by the tenth session. At times in the sessions, she also requested to work on the iPad® independently, without help from the researcher. This theme of independence also came up in the qualitative interview, where Child E reported that one of the things that she did not enjoy about the intervention was when she was "helped" by the researcher, as she preferred to "click on words" and work on the iPad® independently. Here, the themes of independence and interactive engagement ('clicking' on words) are highlighted as advantages of app-based tablet intervention for reading. These advantages create opportunities for increasing dosage of intervention, as children can use the tablets at home, independently and as often as possible

(Enderby, 2012; Togher, 2012). The intervention experience is not solely controlled by the therapist and isolated to the therapy setting.

Other research focusing on technology also suggested similar findings for children with Autism (King et al., 2014), cerebral palsy (Pinto & Gardner, 2014) and for children who use alternative and augmentative communication (AAC)(Hynan et al., 2014). If Child E had greater exposure to the app (i.e. if she had access to a tablet at home) and if she had more intervention session, it is likely that her performance at the end of the intervention would have improved significantly on treated words.

There are an increasing number of studies investigating literacy and intervention with children with Down's syndrome (Bird, Cleave & McConnell, 2000; Cologon, Cupples & Wyver, 2011; Cupples & Iacono, 2002; Kennedy & Flynn, 2003; Lemons & Fuchs, 2010; van Bysterveldt et al., 2006). Baylis and Snowling (2011) reported on a ten week phonologically based literacy programme for ten children with Down's syndrome, in which each child received 20 hours of intervention (two 1 hour sessions per week). Results of this study were favourable regarding the intervention and it was found that all of the children's word reading skills and alphabetic knowledge improved significantly; while some children developed new decoding strategies for reading unfamiliar words. Burgoyne, Duff, Snowling, Buckley and Hulme (2013) reported on an intervention programme designed to teach phoneme blending skills to children with Down's syndrome. Intervention was administered daily for 10 to 15 minutes for a period of six weeks. These authors found that the participants' phoneme bending skills and single word reading improved significantly during the intervention period compared to the pre intervention control period. Therefore, there appears to be a trend of positive outcomes of literacy intervention for children with Down syndrome (Bird, Cleave & McConnell, 2000; Cologon, Cupples & Wyver, 2011; Cupples & Iacono, 2002; Kennedy & Flynn, 2003; Lemons & Fuchs, 2010; van Bysterveldt et al., 2006). The process and findings of this research therefore contributes to the expanding knowledge base on literacy intervention in the Down's syndrome population.

Many of the studies cited used a higher dosage of therapy in comparison to the present study. The children in this study received intervention for two sessions each week, however the intervention was not sustained for a long duration since this was not practical given the scope of the project. Considering the nature of Child E's language, literacy and cognitive difficulties, as well as the nature of her developmental disorder, Child E would have benefited from a greater dosage of intervention compared to her typically developing peers. Therefore, it is likely that Child E's reading would have improved more (in the 'big picture' of general language and literacy assessments) if she had received a greater intensity and dosage of app-based reading intervention.

Immediately after the intervention was completed, each child was interviewed in order to describe their experience of the intervention. In the child interviews, Child F reported that the intervention was too easy and that she would have enjoyed it more had the level been more challenging. Child G echoed this statement by suggesting that there should be different word lists for children in different grades, thereby also alluding to the inclusion of different levels. When children play computer games and game-based apps they often experience challenges when proceeding from one level to the next and therefore they have to 'try and try again' to proceed to higher levels of challenge (Gee, 2003; Inal & Cagaltay, 2007). They often view this as part of the app/technological experience, and not necessarily as failure, but rather as a motivating factor (Gee, 2003). Therapists are often encouraged to help children develop through small steps, in their 'zone of proximal development' (Vygotsky, 1978) and through 'errorless learning' but it may be that children do not need such careful scaffolding when they have the opportunity to persist in this type of therapy. This may especially be the case for children who are delayed rather than having specific disorders, and for children who are motivated and have the desire to succeed. Child F, in particular, reached ceiling within a short time frame and moved from the phrase to the sentence level rapidly. The fact that the reading level was too easy for her may have contributed to her lack of improvement in treated compared to untreated lists at the sentence level. Therefore a suggestion

for future research would be to include more varied levels of difficulty, thereby catering to all reading levels.

Four of the five child participants (Child G, Child B, Child S and Child F) also experienced improvements on post intervention standardized literacy measures which meant that their reading and spelling improved in relation to their typically developing peers. Although it was acknowledged that the standardized assessments contained normative data based on non-local children, each child was compared to themselves from pre to post assessment and so this lack of appropriate normative data was not a concern in terms of the design used here. Child S was one of the children who improved significantly on treated compared to untreated word lists (for both reading levels) at the end of the intervention, as well as over time for both lists. This improvement was also reflected in post intervention standardized literacy measures, which showed that her reading improved in relation to typically developing peers. This suggests that there was across task and across item generalization as both her reading and spelling improved significantly after experiencing the intervention.

The rationale behind using two matched lists – one treated and one untreated in the intervention – was to be able to comment on generalization to untreated items. If the skill trained in the intervention had been mastered by the child, then one would expect generalization of reading from the treated list to the untreated list, as both lists were equally matched for linguistic and phonotactic structure. The reasoning for this is that the child should be able to apply the newly learnt reading skill/strategy to similar words. With this said, one would still expect the treated list to improve somewhat more than the untreated list, as it tends to take some time for generalization to occur.

Other children also experienced generalization, which was evident in post intervention literacy measures. For example, Child G's reading of sight words, spelling, reading rate and reading accuracy of passages improved on standardized literacy assessments from pre to post intervention measures, showing both across item and across task generalization. Child B showed across

item generalization as her reading rate and accuracy of passages improved on post intervention standardized measures in relation to her typically developing peers. At the end of the intervention phase, Child F also improved significantly on treated compared to untreated items at the phrase level of reading; however there was no significant improvement at the sentence level. In terms of Child F's generalization, her reading rate improved in the Neale Analysis of Reading Ability Second Revised Edition (Neale, 1997) and her spelling improved on the ESSI Reading and Spelling Test (Esterhuyse & Beukes, 1997). Therefore she experienced across item (reading rate) and across task (spelling) generalization. Finally, Child E also experienced across task generalization, as evidenced by qualitative post intervention measures. This was despite the fact that there was no significant difference between treated and untreated items at the end of the intervention. The across task generalization was evidenced by her improved blending and segmentation of syllables and phonemes as well as improved rhyme production on qualitative assessment measures. Table 26 summarizes the participants' diagnoses, reading difficulties and main outcomes of the study.

Table 26. Summary of each participant's diagnosis, reading difficulty and outcomes.

Participant	Diagnosis	Nature of reading difficulty (according to Simple View of Reading model (Bishop & Snowling, 2004)).	Summary of outcomes
Child G	Second language learner	Poor comprehender (quadrant D)	<u>Pre intervention assessment:</u> struggled with language and reading. <u>Intervention:</u> reading of both lists improved across time for both reading levels. <u>Post intervention:</u> treated word list improved significantly more than untreated for both reading levels. Improvement on standardized literacy measures.
Child S	General reading difficulties	Poor comprehender (quadrant D)	<u>Pre intervention assessment:</u> inconsistent profile, difficulty with reading of passages <u>Intervention:</u> reading of both lists improved across time for both reading levels. <u>Post intervention:</u> treated word list improved significantly more than untreated for both reading levels. Improvement on standardized literacy measures.
Child B	Second language learner	Poor comprehender (quadrant D)	<u>Pre intervention assessment:</u> struggled with language and reading. <u>Intervention:</u> reading of both lists improved across time for both reading levels. <u>Post intervention:</u> treated word list improved significantly more than untreated for both reading levels improvement on some standardized literacy measures (reading rate and accuracy of passages)
Child F	Specific learning difficulty and word-finding difficulties	Poor comprehender (quadrant D)	<u>Pre intervention assessment:</u> word-finding difficulties in connected speech, some phonological awareness difficulties, poor sight-word reading in texts. <u>Intervention:</u> reading of both lists improved across time for both reading levels (but not from t2 to t3 at the phrase level). <u>Post intervention:</u> treated word list improved significantly more than untreated for phrase level only. Improvement on some standardized literacy measures (spelling, reading rate and accuracy of passages).
Child E	Down's syndrome	Poor comprehender (quadrant D)	<u>Pre intervention assessment:</u> significant language, phonological awareness and literacy delays. <u>Intervention:</u> reading of both lists improved across time <u>Post intervention:</u> no significant difference between treated and untreated lists. Improvement in some phonological awareness skills.

5.3. FUNCTIONAL APPLICATION OF READING MODELS:

The reading models that were used for this study included longitudinal phase models of reading development (Chall, 1967, 1996; Ehri, 1995), an information processing models of spoken and written words (Ellis & Young, 1988, 2002) as well as the reader profile model based on the Simple View of Reading (Bishop & Snowling, 2004). These models allowed for more detailed cognitive-linguistic profiling of spoken and written language and therefore fitted well with the psycholinguistic perspective of the study. Such detailed psycholinguistic profiling was required because of the nature of the design of this study. As this was a single case study design, each child was treated as an individual and their performance was compared to themselves. In the reading intervention literature described in Chapter One, very few of the studies discussed in the review made explicit reference to the use of a model or theory in their research. The present study attempted to make explicit reference to these models, for purposes of understanding the children and their difficulties, and in planning and understanding the intervention outcomes.

The four phase of model of reading development by Ehri (1995) was found to be the most useful in terms of clinical application for describing pre and post intervention reading development. This was due to the highly detailed and descriptive nature of the model, which meant that each child's reading development and skills could be plotted, measured and compared from pre to post intervention. Chall's (1967, 1996) model was somewhat less useful for the beginning readers in this study, as it provided more gross descriptions of reading development. However, this model would be more applicable and useful with older, more efficient readers as it considers the development of higher level language and metalinguistic skills as reading development progresses. These higher level, top-down skills are less relevant for beginning readers, who are learning to read as opposed to 'reading to learn'. Chall's model could be adapted to include more detailed descriptions of literacy and language skills in beginning readers at each developmental level. This could be achieved by including sub

levels within each reading level with detailed descriptions of the exact phonological awareness and literacy skills expected at this phase.

In terms of Ellis and Young's (1988, 2002) information processing model of spoken and written words, there were a few advantages and disadvantages in terms of its clinical application. It was particularly useful for describing processing strengths and weaknesses in children who had difficulties at the single word reading and language level, such as Child G and Child E. This model was somewhat less effective when a child struggled to process stimuli at the level of connected text or speech. For example, in the case of Child S, it was clear that she struggled with longer, more complex spoken and written stimuli. Therefore, because her difficulties were not at the single word level, Ellis and Young's model could not fully capture the nature of her processing difficulties with longer, more complex stimuli. This was also the case for Child B. According to Oakhill et al. (2003), difficulties with reading and understanding passages are most likely due to problems with text integration, metacognitive monitoring and working memory. Wolf (2008) and Norton and Wolf (2012) introduced the idea of the brain's "reading circuit", which involves the rapid integration of a number of neural systems to support successful reading. This reading circuit is able to support every aspect of language as well as other relevant cognitive processes, such as working memory, attention, visual and motor skills, as well as higher level language and cognition (Norton & Wolf, 2012; Wolf, 2008). Therefore, problems with text integration and higher-level cognitive skills may have contributed to weaknesses in reading comprehension and accuracy of longer texts. In order to make Ellis and Young's model more clinically relevant and applicable, it is suggested that it be extended to describe the real-time processing pathways of longer more complex verbal and written stimuli. For example, within each box on the model, a component can address single word processing, while another component of the box could consider processing of connected texts/speech.

There is probably no-one model of reading that is able to include all aspects of the complex process. A range of models was selected at the outset of the project,

which aimed to provide a holistic view of reading from a variety of perspectives. Each model gave a slightly different perspective of each child and their difficulty. In terms of clinical application, therapists may find it helpful to use this multi-model approach, since different models may be useful at different times.

In summary, the ideal model for SLTs working in South African schools would need to be one that (a) makes explicit the links between oral language, written language and phonological awareness; (b) can account for and make links between multiple languages in order to address the needs of multilingual children, with varying proficiency and exposure to each language; (c) allows for a longitudinal view of oral and written language development over time, and (d) can account for different levels of reading proficiency and processing of varying levels (i.e single word processing versus connected text processing). A model that incorporates all of these components was hypothesized from this research and depicted in Figure 17.

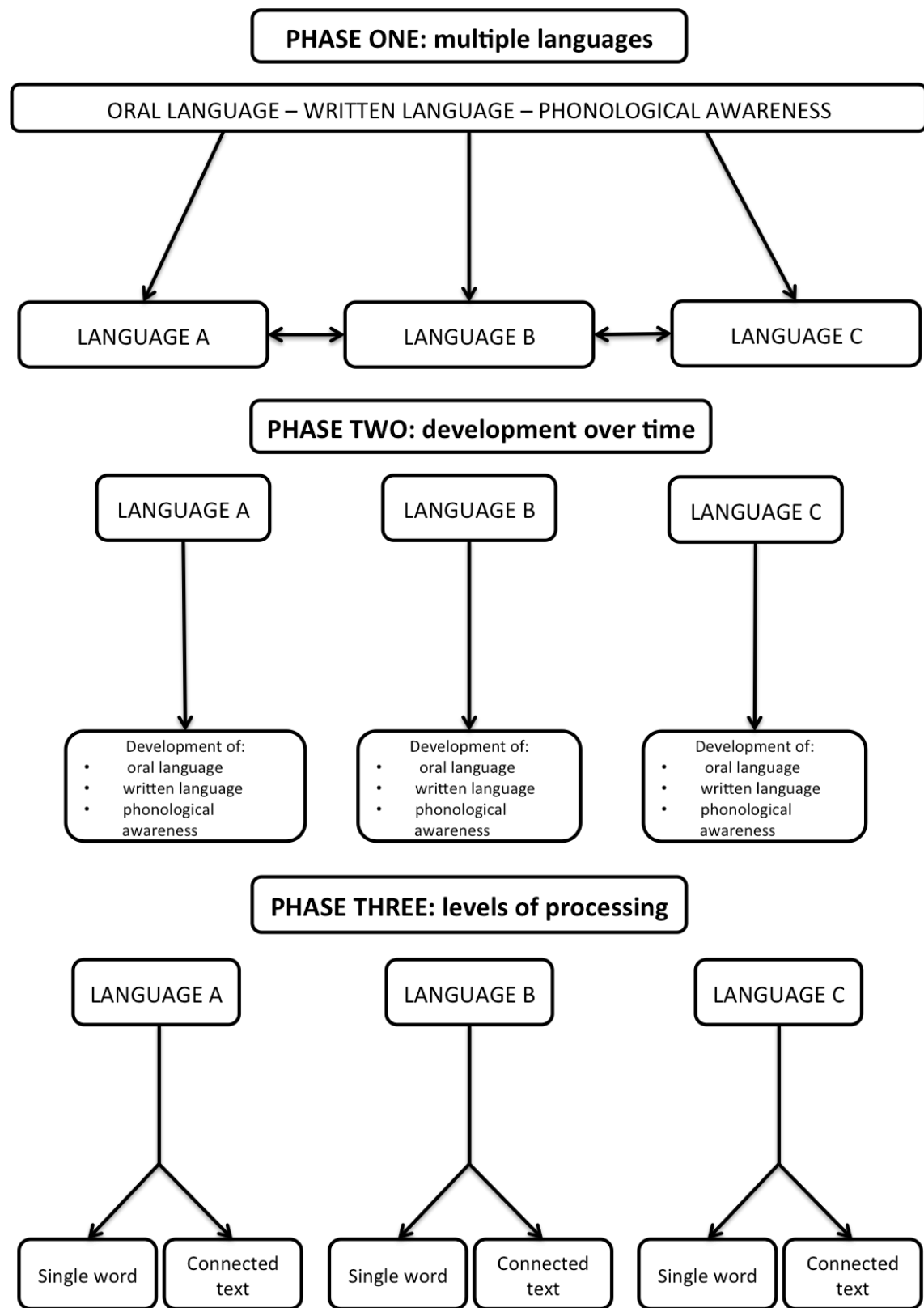


Figure 17. Multi-component phase model of reading

This model shows three different phases. Phase one depicts the different languages the child may speak; and phase two depicts the longitudinal

development of each skill (oral language, written language and phonological awareness) in each language. Finally phase three shows the different levels of processing (single word versus connected text) in each language. This model makes a preliminary attempt at addressing all of the linguistic, developmental and processing components that need to be taken into account when working with reading difficulties in school aged children.

5.4 Reading intervention literature

Key papers on reading intervention were reviewed in Chapter One and were considered in terms of the following criteria: participant characteristics, supporting theories, intervention outcomes, as well as the design, control and generalization reported. This section will discuss how various aspects of this research study relate to the current reading intervention literature.

One of the main contributions of this study is that it adds to the limited literature and knowledge base of reading / SLT intervention research in South Africa. A developing country with limited human and financial resources, a multilingual population, and a history of political oppression, makes this a complex and rich environment in which to study linguistic, educational and cultural phenomena. To date there are few intervention studies that detail the outcomes of reading / SLT interventions with children (Baylis & Snowling, 2011; Best et al., n.d; Burgoyne et al., 2013; Justice & Pullen, 2003; Moriarty & Gillon, 2006; Pascoe et al., 2005). Evidence-based practice is important in the work of both SLTs and teachers. Evidence-based practice is defined by the assumption that clinical skills change and advance with the most recent and current research in the field, and not purely from clinical experience (Ratner, 2006). Due to the evolution and ever-changing nature of the SLT profession, university training and clinical experience alone may not be sufficient in providing SLTs with the expertise to best manage the range of communication disorders that they will be faced with throughout their career (Ratner, 2006). Evidenced-base practice urges clinicians to maintain critical, relevant and careful evaluation of practice.

One of the reasons that there are relatively few published evidence-based practice papers on reading intervention may be because of the challenges that are inherent in intervention studies, such as the fact that they are often time-consuming, and expensive (Penn, 2007). It is also difficult to control for extraneous variables – the effects of race, age, gender, poverty and socio-political history on human behaviour are often profound and cannot be ignored (Penn, 2007). The challenges associated with this study are detailed in the limitations section of the chapter.

Considering more specifically the issue of dosage, there is also limited literature focusing on intervention dosage for speech and language therapy, both in South Africa and internationally, where there is a worldwide call for more published research on this matter. A review by Zeng et al. (2012) evaluated the relationship between dosage, intensity and effect size in 20 randomized control trials of intervention for vocabulary, syntax and phonological interventions. Their study confirmed that specific dosage was often not included in many of the articles they reviewed. Most of the studies in the review specified the dosage and intensity of the intervention, except for those by Isbell et al (2004) and Lonigan et al (1999), in which exact dosage was not specified. The present study contributes to the reading intervention and SLT literature by adding to the research base of articles in which specific details of the process and dosage of intervention were carefully specified.

In the papers reviewed in Chapter One where the exact dosage of intervention was specified, there was great variability in terms of weeks, hours and number of sessions of intervention. The total hours/amount of therapy specified ranged from fifty minutes to ninety hours, and the number of sessions per week were either specified as daily or three times per week. In terms of this single case design study, the total number of hours of intervention ranged from two and a half to six and a half hours (average of five hours) and sessions were conducted twice a week for 20-30 minutes each. The issue of dosage in SLT intervention is a complex one as many factors influence the frequency and intensity of intervention, such as parent/child/SLT time pressures, financial issues, as well

as the nature of the client's diagnosis/es and age (Enderby, 2012). There is also a lack of researched and published literature on therapy dosage (Baker, 2012; Schmitt & Justice, 2012; Zeng et al., 2012), with even less written about it in the South African context. Dosage typically refers to the amount of therapy given. In this study the pre intervention and baseline probe assessments gave children a additional exposure to the app and the items on it that later became part of the therapy. These assessments differed from the therapy because no feedback was given by the researcher (although the children received minimal feedback from the app itself in the form of a recorded score of correct and incorrect responses on the top right hand corner of the iPad® screen). This raises an interesting issue, in that these assessments may actually have unintentionally increased dosage and developed the children's abilities prior to the official onset of the therapy. This leads to the linked question of how important is the SLTs mediating role in intervention?

The literature suggests that the therapist has a very important mediating role in computer-based intervention (Vance & Clegg, 2014), and in most discussions of computer usage in therapy, authors (Vance & Clegg, 2014; Wolf et al., 2012) definitively state that therapists are not in danger of being replaced by a computer. The role of the therapist is invaluable in understanding the specific nature of complex difficulties, such as the links between personality, psychosocial difficulties, educational and communication difficulties. The difficulties faced in this study with achieving a stable/static baseline suggest that the children were improving in their reading after their initial exposure to the items on the app (in the pre intervention probe assessments). Although the researcher did not provide any feedback/cues about what was correct or incorrect, the app did. Although this did not seem relevant in the planning phases of this research, it is clear that this feedback and exposure to the app prior to intervention had important implications and effects. Although it is not suggested that the therapist not be involved and present, it may be that his / her role is somewhat less important than first assumed. Therefore, once the therapist has selected the appropriate level and stimuli, he/she may not need to be actively involved in the app based intervention throughout the entire session.

The implications of this would be that once the child's difficulties are understood, they would have the opportunity to work more independently so that dosage can be increased and cost-effectiveness can be maximized. The potential benefits of this are great and are discussed in greater detail later on in the chapter.

With this said, in the child interviews some of the children (Child G, Child S and Child B) expressed that they enjoyed the mediation and interaction in the session. Therefore, although the researcher's involvement in mediating the sessions contributed to some of the children's enjoyment, it may not have been necessary for the main researcher to be actively involved throughout the entire session, and potentially this involvement could have been reduced.

In addition to contributing to knowledge of dosage and independence, this single case intervention study used a carefully planned, detailed, individualized intervention research procedure that focused not only on the outcomes of the intervention, but also on the process as a whole. This was due to the nature of the single case study design, whereby each child's cognitive linguistic profile is carefully described and detailed and where their performance and intervention outcomes are compared to themselves. Comparing each child's performance to him/herself was achieved with the use of probe items administered at various points through out the intervention as well as with the use of a baseline control period prior to the start of intervention. Probe items were administered at the time of the initial assessment, after the baseline control period and again immediately post intervention. This allowed for a comparison of the participants' performance across time.

In terms of the baseline control period, the formation of a stable pre intervention baseline assumes that the child's performance after the intervention was due to the intervention itself and not due to maturation/ development. In this study, it was not possible to achieve a static pre intervention baseline. Reasons for this may be that the children were still in the process of developing, were learning due to their classroom experiences and that the assessments had already

triggered their learning – in fact intervention had actually started. Engel and Schutt (2014) state that a significant improvement during the baseline period can be caused by a number of factors, one of these being maturation during the baseline period. This improvement was also likely influenced by the heavy focus on reading and literacy in the classroom. However, with the use of t-tests and untreated probe items, it was still possible to determine the improvement as a result of the intervention – that went over and beyond the improvement that had already been noted in the baseline phase.

Despite this being a small-scale study, it showed that the intervention was effective for all participants and also highlighted the individual variability of app-based reading intervention from child to child. There are other studies which have struggled to achieve a stable/static baseline and some which have not attempted to track a baseline at all, perhaps because of the acknowledged challenges of doing so with young children (e.g. Pascoe, Stackhouse and Wells, 2005). Mitchell and Jolley (2013) note: “Although it is difficult to achieve a stable baseline, we should point out that single-n researchers often do achieve it. They are especially successful when they put a simple organism (e.g. a pigeon) in a simple environment (e.g. a Skinner box) and have it perform a simple behavior (e.g. peck a disk).” (p. 573). Therefore the complexities of developing children and their learning suggest a stable baseline may be very difficult to achieve.

5.5. EDUCATIONAL AND CLINICAL IMPLICATIONS:

SLTs working in South Africa have an important role to play in identifying, assessing and managing children with spoken and /or written language difficulties. Findings from this study provide therapists with some evidence based suggestions that may support them in this work.

There are a range of reading models and theories that can be used to assist in the understanding the links between spoken and written language, the long term unfolding of language over time and the difficulties that occur in a given moment. Figure 17 was inspired by the models used in this research (see Bishop & Snowling, 2004; Chall, 1967, 1996; Ehri, 1995; Ellis & Young, 1988, 2002) and

was devised in order to address some of these important components in reading. Another reason for devising this model was to address the limitations of the theoretical models used in this research.

It is an enormous task to devise and research a comprehensive, multi-component model of reading, because reading itself is a highly complex task. Reading requires an extremely intricate circuit that involves the rapid integration of a number of neural systems to support successful reading. This reading circuit taps into every aspect of language (e.g. morphology, syntax, phonology, semantics and pragmatics) as well as other relevant cognitive processes, such as working memory, attention, visual and motor skills, and higher level language and cognition (Norton & Wolf, 2012; Wolf, 2008). Therefore, if SLTs are to make a significant difference in managing children's reading difficulties, they need to fully develop their understanding of this complex phenomenon in order provide the most appropriate intervention plan. Therefore, SLTs working in schools and education are urged to become experts in the theory and management of reading and the linguistic aspects related to this, through active engagement and critical review of the literature in the field (Penn, 2007). An improved knowledge base of the theory and research of reading will inform the quality of services and evidence based practices that the SLT is capable of providing. The importance of adopting critical thinking strategies, remaining up to date with current best practice in the field, as well as contributing to the scarce research base are all crucial in supporting the standards and longevity of the profession. This is especially relevant in South African schools, where SLTs are vastly underrepresented, and where innovative strategies are needed to demonstrate the role and interventions that SLTs provide for supporting spoken and written language development.

Due to the descriptive, detailed nature of this type of single case study, it would be possible for another SLT working in education to replicate the process documented in this thesis. The outcomes of these potential studies of a similar nature would contribute to the evidence that demonstrates the value of SLTs in schools. The intervention does not need to be app based – instead, what is

important is the intervention process, which should be carefully detailed, planned and theoretically motivated.

As discussed in Chapter One, SLTs are currently vastly under-represented in South Africa's public education system because they have not had the opportunity to highlight and demonstrate their roles in supporting general education (Kathard et al, 2011; Wium & Louw, 2013). Within a constrained human resource capacity, SLTs need to develop creative strategies to make visible links between language and learning so as to align themselves with general education (Kathard et al, 2011; Lewis, 2004; Wium & Louw, 2013).

Collaboration in the classroom environment in particular is vitally important in establishing a conceptual connection between language and learning (Kathard et al., 2011; Wium & Louw, 2013). With South Africa's education system striving towards inclusion and whole-classroom based interventions, SLTs need to develop new strategies to remain relevant in the education setting.

Collaboration in the classroom is twofold – that is, it requires the SLT to work together with both learners and teachers. In terms of learner support in the classroom, SLTs need to play a preventative and supportive role, which includes the prevention of further learning difficulties in at-risk learners as well as the promotion of spoken and written language development in all learners. As this approach needs to be inclusive, all learners should be targeted in classroom based interventions; and the use of tablets provides an opportunity for SLTs and teachers to address a larger number of learners' communication needs. For example, future research could investigate the use of tablets with at-risk learners, within larger groups of children (group sessions), mediated by trained teachers or SLTs. Due to the favourable outcomes of this research, the use of tablets and app-based interventions in the classroom should be considered as another avenue for SLT-teacher collaboration. In terms of teacher collaboration, SLTs can provide CPD activities to teachers in order to train them to use app based tablet interventions to support the development of spoken and written language in all learners. The multi-component reading model depicted in Figure 17 could also be used in workshops with teachers and other SLTs to help

understand the complexity of reading, language and multiple language/literacy acquisition.

In view of the independent nature of this app based intervention, teachers, assistants and support staff could be trained to assist in administering the intervention, as the study showed that the SLT may not need to be actively involved throughout the process. The teachers in turn can consult with SLTs on curriculum matters in order to ensure that the level of intervention is appropriate for the particular grade and stage of learning. There is also the capacity for SLTs to collaborate at higher, strategic levels of education by advocating for all learners' communication needs. The favourable results of this study provide motivation for future research on the use of tablets as a vehicle for facilitating the development of spoken and written language in school aged children. Ultimately, the hope would be that tablet based learning would be implemented in order to support spoken and written language development of all learners in the classroom.

5.6. LIMITATIONS:

This study has several limitations which are discussed in this section. The limitations include the lack of generalizability of the study to the wider population, the involvement of the researcher, the limited dosage, access to the iPad®, the software itself and issues with obtaining the stable baseline.

This was a small scale, preliminary study which aimed to explore the outcomes of a novel intervention for children with reading difficulties. As a result of the limited research and uncertainty about the benefits of this intervention, a small number of children, who otherwise would not have received intervention, participated in the study. Results indicated that the therapy was effective in bringing about improved reading, however because of the nature of the study's design, the results cannot be generalized to the wider population of children with reading difficulties. Further studies that control more tightly for a range of variables will be needed and further evaluations of effectiveness and efficiency will need to be conducted (as per Robey and Schultz's (1998) intervention

outcomes research model). Despite this limitation, the findings indicate it is likely that children will enjoy the intervention and will make improvements in reading. This type of efficacy research is an important first step in the hierarchy of evaluating the outcomes of an intervention (Robey and Schultz, 1998).

At the outset of the study, the concept of reading comprehension was considered in the stricter sense, with more of a focus on the aspect of language comprehension. After considering the results from the app and the theoretical models of reading, it was decided that this was somewhat of a limited view, and that the study should rather consider the concept of reading in the broader sense – that is, the integration of cognitive, linguistic and decoding processes. To narrowly define reading comprehension and narrowly intervene in this aspect alone is very challenging, as the ability to read requires the integration of a number of skills. Therefore, studies in the literature have generally taken a broader view of reading.

The researcher was involved in the data collection (assessment and intervention) with each participant. Onwuegbuzie and Leech (2007b) noted it is desirable to have assessment and therapy carried out by those not involved in the study since they are likely to be more neutral and less invested in the process. In the present study this was not possible due to a limited budget. In order to address this, the researcher introduced a number of control measures in order to avoid bias. These included the use of the Fidelity Checklist (Appendix F) to document and monitor environmental and behavioural factors and iPad® usage in other settings (e.g. home environment). Another control measure included inter-rater reliability, in which a subset of the data (10-20% for each child) was given to another SLT who was uninvolved in the study. The extent to which the researcher and SLT agreed provided a measure of consistency of the research procedure and findings (Irwin et al., 2008; Pascoe et al., 2006; Silverman, 2010). This agreement was also within the boundaries of a 95% confidence level. In addition, the participants' scores were measured and recorded by the app itself. This objective measure eliminated the risk of human error. Therefore despite the main researcher being involved in the participants'

assessments and intervention, various control measures were put in place in order to counteract any potential bias.

Due to time restrictions, the children received a relatively small amount of intervention (an average of five hours). Even though Baker (2012) and Enderby (2012) advise that simply increasing the dosage may not be a viable way to enhance learning of a skill (particularly in the case of emergent literacy (Schmitt & Justice, 2012)), it would have been interesting to see how the children would have responded to the intervention if they received a higher dosage. In the reading intervention literature discussed in Chapter One, a wide range of intervention dosage was reported. The dosage did not appear to correlate with the positive intervention outcomes, as many of the studies with a relatively low intervention dosage still reported favourable intervention outcomes (see Lonigan et al., 1999; McGee & Johnson, 2003; Oakhill & Patel, 1991). As previously mentioned, it may be that the intervention dosage was unwittingly larger than originally intended due to the additional exposure received during the initial probe assessments. This was possibly an unintended advantage of the design and may have increased the dosage by one to two hours.

Linked to the points made above, the iPad® was not available to the children for the entire duration of the study and although some children had access to an iPad® at home, they did not have the app. This meant that they only used the app in the designated intervention sessions with the researcher. One way of increasing the dosage would have been to give children access to their own iPad® or a shared license for the app so that they could practice at home on their own. Although this would have increased dosage, it was not practical for this study due to financial constraints and also because it was felt important to observe the intervention and be involved in the child's therapy process. Since the children benefited from the intervention, despite the limited dosage and the controlled access they had to the app, it is likely that if given more opportunity and independence, they may have improved even more.

The software used in this study was originally designed in Canada for use with adults who suffered from neurological communication difficulties. Therefore the design of the app had some inherent limitations - such as items that were culturally or age inappropriate. In addition to this, the app was only available in English and therefore limited the work in the project to English-speaking children only. Given our multicultural and multilingual environment, there is a great need for the development of the app in more languages and with culturally relevant items, designed specifically with children in mind.

5.8. SUGGESTIONS FOR FUTURE RESEARCH:

Now that the efficacy of this intervention has been evaluated, the next steps would be to investigate the effectiveness and efficiency of the intervention research process, as recommended by Robey and Schultz (1998) as best practice for intervention outcomes research.

In order to investigate the effectiveness of the intervention, the research would need to be conducted in a realistic, practical setting that is reflective of the real world situation of SLTs in schools in South Africa (Pascoe et al., 2006; Robey & Schultz, 1998; Wertz & Katz, 2004). Firstly, it would be beneficial to trial this app based reading intervention with a larger number of children, with greater measures of control, such as the use of a non-intervention control group and a main researcher that is uninvolved in the participants' research process.

Another suggestion would be to evaluate the effectiveness of this intervention with different subpopulations (e.g. children with Down's syndrome or second language learners).

This effectiveness research could potentially be modeled on the study by Clarke et al. (2010), which was a randomized control trial of 84 nine year old children with specific reading comprehension impairment. In this study, children each received 20 hours of intervention (in one of three reading programmes). This study made use of a large number of participants, a non-intervention control group and use of standardized assessment tools, and the randomized control

design – all of which are stringent control measures.

Another idea for evaluating the effectiveness of this app based reading intervention would be to research how well the intervention can be incorporated into the current, traditional interventions that most SLTs employ, as well as ways in which SLTs might modify this intervention process to suit a wide array of children's reading needs. Effectiveness studies could also explore the ideal dosage and setting for this type of intervention (i.e. in the therapy room, or as a home programme). As SLTs in South Africa deal with children who have a wide array of reading and language requirements, different levels of difficulty and different languages in the app should be also investigated. There is research taking place in South Africa in terms of resource development in other languages, such as that by Maphalala, Pascoe and Smouse (2014) who devised and researched an isiXhosa speech assessment tool. Some of this work could be extended to include the development of app-based assessments and intervention in isiXhosa and other South African languages.

The final stages of intervention outcomes research should include an evaluation of the efficiency of the intervention (Robey & Schultz, 1998). This refers to an evaluation of its cost effectiveness and time effectiveness. A suggestion for evaluating the efficiency of this intervention would be for SLTs to train teachers, assistants or support staff to conduct the app based intervention with children in the classroom. Evaluating the cost and time effectiveness of group intervention or home practice with parents could also be explored.

5.9. CONCLUSION:

This study detailed an individualized app based intervention for children with reading difficulties in the South African context. The study makes contributions in two main areas. Firstly, it adds to the knowledge base on reading, reading development and how five individual children with very different reading and language profiles responded to intervention. Findings showed that all of the children's reading improved in a number of ways. All of the children's reading of treated and untreated items improved significantly over time, from the initial

assessment to the end of the intervention. Some of the children's (Child G, B, S, F) reading of treated items improved significantly more than the untreated items at the end of the intervention, which suggested that the intervention was successful at improving reading of treated items (but not for all reading levels (i.e. Child F)). Some children also improved on post intervention standardized literacy measures in comparison to their typically developing peers, which was suggestive of wider generalization beyond the specific set of items addressed. In addition, all children reported enjoying the intervention, but some made suggestions regarding a greater level of difficulty and complexity in the intervention. The findings were then related to models of reading, which were used to plan intervention and understand the outcomes achieved.

Secondly, the study has implications for SLTs who may wish to replicate the assessment and intervention process that was carefully detailed in this study and/or use it to support their clinical work with children. It is also suggested that models/theories should be an important part of the SLTs therapy planning. In this study, prominent reading models of development (Chall, 1967, 1996; Ehri, 1995), information processing (Ellis & Young, 1988, 2002) and profiling (Bishop & Snowling, 2004) models were used to describe and compare the participants' reading skills at points throughout the intervention process. Although these models had aspects that were useful in clinical and research application, they also had some limitations. In order to address these limitations, the researcher devised a preliminary multi-component model to account for all the factors that impact on reading, such as different languages (i.e. multilingualism), longitudinal development, and different levels of processing (see Figure 17). The model may be used as a framework in working with teachers and SLTs in school settings. The app based intervention has potential to be used in a more independent way, which would be helpful for increasing dosage for individual children and for making SLTs more cost effective. Further suggestions for maximizing cost and time effectiveness included group sessions, home programmes with parents and training of support staff to administer the intervention.

One of the challenges faced in the study included obtaining a stable baseline, which was caused by the complexities of working with developing children. However, the use of statistics and visual graph analysis allowed for detailed analysis and comparison of results. Other challenges included limited intervention dosage caused by time restrictions, a small sample size and a researcher who was involved in the participants' assessment and intervention. These limitations could be addressed in future research by including matched non-intervention control groups; with a larger sample size in order to make generalizations to the rest of the population; as well as more research staff to administer the intervention as opposed to the main researcher (eliminating research bias).

Children with literacy difficulties are at risk for further academic failure, which may ultimately limit their academic achievement and employment opportunities later on in life. This study has focused on developing an intervention for supporting children with reading difficulties with the use of an app based tablet, with opportunities for increasing dosage and maximizing cost and time effectiveness. This research has a number of important implications for reading intervention for school aged children within the unique South African context.

References

- Alexander, N. (Ed.) (2005). *Mother tongue-based bilingual education in South Africa: The dynamics of education*. Cape Town: Salty Print.
- American Speech-Language-Hearing Association (ASHA) (2010). Roles and responsibilities of speech-language pathologists in schools [Professional Issues Statement]. www.asha.org/policy.
- Anthony, A., Bogle, D., Ingram, T. T. S., & McIsaac, M. W. (1971). *Edinburgh Articulation Test*. Edinburgh, U.K.: Churchill Livingstone.
- Anthony, J.L. & Francis, D.J. (2005). Development of phonological awareness. *American Psychological Society*, 14(5), 255-259.
- Arnell, K.M., Joanisse, M.F., Klein, R.M., Busseri, M.A. & Tannock, R. (2009). Decomposing the relation between Rapid Automated Naming (RAN) and reading ability. *Canadian Journal of Experimental Psychology*, 63(3), 173-184.
- Babbie, E., & Mouton, J. (2005). *The practice of social research*. Cape Town, South Africa: Oxford University Press Southern Africa.
- Baker, E. (2012). Optimal intervention intensity in speech-language pathology: Discoveries, challenges, and uncharted territories. *International Journal of Speech-Language Pathology*, 14(5), 478-485.
- Barger-Anderson, R., Domaracki, J. W., Kearney-Vakulick, N., & Kubina Jr., R. M. (2004). Multiple baseline designs: The use of a single-case experimental design in literacy research. *Reading Improvement*, 41(4), 217-225.
- Basso, A. (2005). How intensive/prolonged should an intensive/prolonged treatment be? *Aphasiology*, 19(10), 975-984.

- Bauer, K.L., Iyer, S.N., Boon, R.T. & Fore, C. (2010). 20 ways for classroom teachers to collaborate with speech-language pathologists. *Intervention in School and Clinic*, 45, 333-337.
- Baumann, J. F. (2009). Intensity in vocabulary instruction and effects on reading comprehension. *Topics in Language Disorders*, 29(4), 312.
- Baylis, P., & Snowling, M. J. (2011). Evaluation of a phonological reading programme for children with Down syndrome. *Child Language Teaching & Therapy*, 28(1), 39-56.
- Beauchamp, T. (Ed.). (2007). *The 'four principles' approach to health care ethics* (2nd ed.). West Sussex, England: John Wiley & Sons.
- Beck, I.L., McKeown, M.G., & Kucan, L. (2002). *Bringing words to life*. New York: Guilford Press.
- Beech, J.R. (2005). Ehri's model of phases of learning to read: A brief critique. *Journal of Research in Reading*, 28(1), 50-58.
- Bell, N. (1986). *Visualizing and verbalizing for language comprehension and thinking*. Paso Robles, CA: Academy of Reading Publications.
- Berg, B. L., & Lune, H. (2004). *Qualitative research methods for the social sciences*. Boston: Pearson.
- Best, W., Fedor, A., Hughes, L., Kapikian, A., Masterson, J., Roncoli, S., et al. (n.d). Intervening to alleviate word-finding difficulties in children: Case series data and a neurocomputational foundation. Unpublished manuscript.

- Bird, E. K. R., Cleave, P. L. & McConnell, L. (2000). Reading and phonological awareness in children With Down syndrome: A Longitudinal Study. *American Journal of Speech-Language Pathology*, 9(4), 319-330.
- Bishop, D. V. M., & Snowling, M. J. (2004). Developmental dyslexia and specific language impairment: Same or different? *Psychological Bulletin*, 130(6), 858-886.
- Bohlmann, C. & Pretorius, E.J. (2002). Reading skills and mathematics. *South African Journal of Higher Education*, 16(3), 196-206.
- Bowyer-Crane, C., Snowling, M.J., Duff, F.J., Fieldsend, E., Carroll, J.M., Miles, J., Gotz, K. & Hulme, C. (2007). Improving early language and literacy skills: differential effects of an oral language versus a phonology with reading intervention. *Journal of Child Psychology and Psychiatry*, 49(4), 422-432.
- Brady, M. C., Kelly, H., Godwin, J., & Enderby, P. (2012). *Speech and language therapy for aphasia following stroke*. Cochrane Database of Systematic Reviews 2010, Issue 5. Art. No.: CD000425.
- Brock-Utne, B., & Skattum, I. (2009). *Language and education in Africa: A comparative and transdisciplinary analysis*. Oxford: Symposium Books.
- Broom, Y. (2004). Reading English in multilingual South African primary schools. *Bilingual Education and Bilingualism*, 7(6), 506-528.
- Burgoyne, K., Duff, F., Snowling, M., Buckley, S., & Hulme, C. (2013). Training phoneme blending skills in children with Down syndrome. *Child Language Teaching and Therapy*, 29(3), 273-290.
- Bush, L. & Hall, J. (2012). iRead and iLearn: Utilizing iOS applications in children's literature. *Society for International Learning and Teacher Education International Conference*, 1, 2731-2733.

- Byiers, B. J., Reichle, J., & Symons, F. J. (2012). Single-subject experimental design for evidence-based practice. *American Journal of Speech-Language Pathology*, 21(4), 397-414.
- Castles, A. (2006). The dual route model and the developmental dyslexias. *London Review of Education*, 4(1), 49-61.
- Catts, H. W., Bridges, M. S., Little, T. D., & Tomblin, J. B. (2008). Reading achievement growth in children with language impairments. *Journal of Speech, Language & Hearing Research*, 51(6), 1569-1579.
- Carroll, J. M., & Snowling, M. J. (2004). Language and phonological skills in children at high risk of reading difficulties. *Journal of Child Psychology and Psychiatry*, 45(3), 631-640.
- Centre for Evaluation and Assessment (2006). *PIRLS of wisdom: The what, where, when and how of the international reading literacy study in South Africa*. Pretoria: Faculty of Education, University of Pretoria.
- Chall, J. (1967). *Learning to read: The great debate*. New York: McGraw-Hill.
- Chall, J.S. (1996). *Stages of reading development, 2nd edition*. Orlando, FL: Harcourt Brace & Company.
- Cheung, H., Chen, H. C., Lai, C. Y., Wong, O. C., & Hills, M. (2001). The development of phonological awareness: Effects of spoken language experience and orthography. *Cognition*, 81(3), 227-241.
- Chomsky, N. (1957). *Syntactic structures*. The Hague, The Netherlands: Morton.
- Cipolotti, L. & Butterworth, B. (1995). Toward a multiroute model of number processing: Impaired number transcoding with preserved calculation skills. *Journal of Experimental Psychology: General*, 124(4), 375.

- Clarke, P.J., Hulme, C. & Snowling, M.J. (2005). Individual differences in RAN and reading: a response timing analysis. *Journal of Research in Reading*, 28(2), 73-86.
- Clarke, P. J., Snowling, M. J., Truelove, E., & Hulme, C. (2010). Ameliorating children's reading-comprehension difficulties: A randomized controlled trial. *Psychological Science*, 21(8), 1106-1116.
- Collingridge, D. S., & Gantt, E. E. (2008). The quality of qualitative research. *American Journal of Medical Quality*, 23(5), 389-395.
- Cologon, K., Cupples, L., & Wyver, S. (2011). Effects of targeted reading instruction on phonological awareness and phonic decoding in children with Down syndrome. *American Journal on Intellectual and Developmental Disabilities*, 116(2), 111-129.
- Coltheart, M. (2006a). Dual route and connectionist models of reading: an overview. *London Review of Education*, 4(1), 5-17.
- Coltheart, M. (2006b). Acquired dyslexias and the computational modelling of reading. *Cognitive Neuropsychology*, 23(1), 96-109.
- Coltheart, M., Curtis, B., Atkins, P., & Haller, M. (1993). Models of reading aloud: Dual-route and parallel-distributed-processing approaches. *Psychological Review*, 100, 589-608.
- Coltheart, M., & Rastle, K. (1994). Serial processing in reading aloud: Evidence for dual-route models of reading. *Journal of Experimental Psychology: Human Perception and Performance*, 20, 1197-1211.

- Coltheart, M., Rastle, K., Perry, C., Langdon, R. & Ziegler, J. (2001). DRC: a dual route cascaded model of visual word recognition and reading aloud. *Psychological Review*, 108(1), 204-256.
- Constantinescu, A. I. (2007). Using technology to assist in vocabulary acquisition and reading comprehension. *The Internet TESL Journal*, 13(2).
- Cupples, L., & Iacono, T. (2002). The efficacy of 'whole word' versus 'analytic' reading instruction for children with Down syndrome. *Reading and Writing*, 15(5-6), 549-574.
- Cutting, L. E, Materek, A., Cole, C. A. S., Levine, T. M. & Mahone, E. M. (2009). Effects of fluency, oral language and executive function on reading comprehension performance. *Annals of Dyslexia*, 59(1), 34-54.
- Denton, C.A., Fletcher, J.M., Anthony, J.L. & Francis, D.J. (2006). An evaluation of intensive intervention for students with persistent reading difficulties. *Journal of Learning Disabilities*, 39(5), 447-466.
- Department of Basic Education (2011b). *Report on Annual National Assessment of 2011*. Retrieved on 28 April 2014 from <http://www.education.gov.za/LinkClick.aspx?fileticket=1U5igeVjiqg%3D&tabid=424&mid=183>.
- Department of Education (1996b). *The South African Schools Act, Act 84 of 1996*. Retrieved on 11 May 2014 from <http://www.education.gov.za/LinkClick.aspx?fileticket=KaOWgo8oYyg=>.
- Department of Education (1996c). *National Education Policy Act of 1996*. Retrieved on 11 May 2014 from <http://www.education.gov.za/LinkClick.aspx?fileticket=WTGxHzBEbiQ=>.

- Department of Education (1998). National norms and standards for school funding. Retrieved on 11 May 2014 from <http://www.education.gov.za/LinkClick.aspx?fileticket=ZYYtOiXHTeE%D&tabid=188&mid=498>.
- Department of Education (2001b). *Education White Paper 6: Special needs education – Building an inclusive education and training system*. Pretoria: Department of Education.
- Department of Education. (2005). *Grade Six Intermediate Phase Systematic Evaluation Report*. Pretoria: Department of Education.
- Duke, N. K., & Pearson, P. D. (2008). Effective practices for developing reading comprehension. *Journal of Education*, 189(1), 107-122.
- Du Plessis, S. & Louw, B. (2008). Challenges to preschool teachers in learners' acquisition of English as language of learning and teaching. *South African Journal of Education*, 28, 53-75.
- Edwards, S., Fletcher, P., Garman, M., Hughes, A., Letts, C. & Sinka, I. (1997). *The Reynell Developmental Language Scales* (3rd edn). Windsor: NFER-Nelson.
- Ehri, L. C. (1995). Phases of development in learning to read words by sight. *Journal of Research in Reading*, 18, 116-125.
- Ehri, L.C. (2005). Learning to read words: theory, findings and issues. *Scientific Studies of Reading*, 9(2), 167-188.
- Ehri, L.C. (2013). Grapheme-phoneme knowledge is essential for learning to read words in English. In J.L. Metsala & L.C. Ehri (Eds), *Word recognition in beginning literacy*, (pp. 3-40). New York: Routledge.

- Ehri, L.C. & McCormick, S. (1998). Phases of word learning: Implications for instruction with delayed and disabled readers. *Reading and Writing Quarterly: Overcoming Learning Difficulties*, 14(2), 135-163.
- Ehrlich, M.F., Remond, M., & Tardieu, H. (1999). Processing of anaphoric devices in young skilled and less skilled comprehenders: Differences in metacognitive monitoring. *Reading and Writing*, 11, 29-63.
- Ellis, A. W., & Young, A. W. (1988). *Human cognitive neuropsychology*. London: Erlbaum.
- Ellis, A.W., & Young, A.W. (2002). *Human cognitive neuropsychology: A textbook with readings*. East Sussex, UK: Psychology Press Ltd.
- Ellis, A.W., & Young, A.W. (2013). *Human cognitive neuropsychology: A textbook with readings*. East Sussex, UK: Psychology Press Ltd.
- Enderby, P. (2012). How much therapy is enough? The impossible question! *International Journal of Speech-Language Pathology*, 14(5), 432-437.
- Engel, R.J. & Schutt, R.K. (2014). Single-subject design. In *fundamentals of social work research*. (2nd edn.). USA: Sage Publications.
- Esterhyse, K.G.F. & Beukes. RBI. (1997). *ESSI Reading and Spelling test*. Free State: University of the Free State, Department of Psychology.
- Fawcett, A. J. & Nicolson, R. I. (2002). Children with dyslexia are slow to articulate a single speech gesture. *Dyslexia*, 8(4), 189-203.
- Fitzgerald, J. & Shanahan, T. (2000). Reading and writing relations and their development. *Educational Psychologist*, 35(1), 39-50.

- Fleisch, B. (2008). *Primary education in crisis: why South African school children underachieve in reading and mathematics*. Cape Town: Juta
- Flick, U. (2014). *An introduction to qualitative research*. London: Sage Publications.
- Frederickson, N., Frith, U., & Reason, R. (1997). *Phonological Assessment Battery*. Windsor: NFER-Nelson.
- Frith, U. (1985). Beneath the surface of developmental dyslexia. In Patterson, K.E., Marshall, J.C., Coltheart, M. (Eds), *Surface Dyslexia* (pp. 301-330). London: Routledge and Kegan Paul.
- Gallagher, A., Frith, U. & Snowling, M.J. (2000). Precursors of literacy delay among children at genetic risk of dyslexia. *Journal of Child Psychology and Psychiatry*, 41(2), 203-213.
- Gee, J.P. (2003). What video games have to teach us about learning and literacy. *Computers in Entertainment (CIE)*, 1(1), 1-4.
- Georgiou, G.K., Parrila, R., & Liao, C.H. (2008). Rapid naming speed and reading across languages that vary in orthographic consistency. *Reading and Writing: An Interdisciplinary Journal*, 21, 885–903.
- Gillon, G. T. (2002). Follow-up study investigating the benefits of phonological awareness intervention for children with spoken language impairment. *International Journal of Language and Communication Disorders*, 37(4), 381-400.
- Gillon, G. T. (2004). *Phonological awareness: From research to practice*. New York: Guilford Press.

- Goswami, U. (1993). Toward an interactive analogy model of reading development: Decoding vowel graphemes in beginning reading. *Journal of Experimental Child Psychology*, 56(3), 443-475.
- Goswami, U. (2000). Phonological representations, reading development and dyslexia: Towards a cross-linguistic theoretical framework. *Dyslexia*, 6(2), 133-151.
- Gough, P.B., & Tunmer, W.E. (1986). Decoding, reading and reading disability. *Remedial and Special Education*, 7, 6-10.
- Graham, J. E., Karmarkar, A. M., & Ottenbacher, K. J. (2012). Small sample research designs for evidence-based rehabilitation: Issues and methods. *Archives of Physical Medicine and Rehabilitation*, 93(8), 111-116.
- GraphPad Software (2014). *QuickCalcs*. Retrieved 29 July 2014, from <http://www.graphpad.com/quickcalcs/ttest1/>.
- Gustafson, S. (2000). *Varieties of reading disability: phonological and orthographic word decoding deficits and implications for interventions*. Swedish Institute for Disability Research, Report 1, Linkopings: Linkopings University.
- Guthrie, J.T., Wigfield, A., Humenick, M.N., Perencivich, K.C., Taboada, A. & Barbosa, P. (2006). Influences of stimulating tasks on reading motivation and comprehension. *Journal of Educational Research*, 99(4), 232-244.
- Harley, T.A. (Ed.). (2001). *The psychology of language: From data to theory*. (2nd edn). East Sussex, UK: Psychology Press Ltd.
- Harm, M.W. & Seidenberg, M.S. (1999). Phonology, reading acquisition and dyslexia: Insights from connectionist models. *Psychological Review*, 106, 491-528.

- Heugh, K. (2009). Into the cauldron: An interplay of indigenous and globalized knowledge with strong and weak notions of language and literacy education in Ethiopia and South Africa. *Language Matters*, 40(2), 166-189.
- Høien, T., & Lundberg, I. (1988). Stages of word recognition in early reading development. *Scandinavian Journal of Educational Research*, 32, 163-182.
- Høien, T., & Lundberg, I. (2000). *Dyslexia: From theory to intervention* (Vol. 18). Netherlands: Kluwer Academic Publishers.
- Hoover, W. A., & Gough, P. B. (1990). The simple view of reading. *Reading and Writing*, 2, 127-160.
- Horner, R. H., Carr, E. G., Halle, J., McGee, G., Odom, S., & Wolery, M. (2005). The use of single-subject research to identify evidence-based practice in special education. *Exceptional Children*, 71(2), 165-179.
- Howie, S. (2005a). Contextual factors in the school and classroom level related to pupils' performance in mathematics in South Africa. *Educational Research and Development*, 11(2), 123-140.
- Howie, S. (2005b). System-level evaluation: Language and other background factors affecting mathematics achievement. *Prospects*, 64(1), 119-157.
- Howie, S., Venter, E., Van Staden, S., Zimmerman, L., Long, C., Du Toit, C., Scherman, V., & Archer, E. (2008). *Progress in international reading literacy study summary report: South african children's reading literacy achievement*. Pretoria: Centre for Evaluation and Assessment, University of Pretoria.
- Hulme, C., Hatcher, P., Nation, K., Brown, A., Adams, J. & Stuart, G. (2002). Phoneme awareness is a better predictor of reading skill than onset-rime awareness. *Journal of Experimental Child Psychology*, 82, 2-28.

- Hulme, C., & Snowling, M. (1992). Deficits in output phonology: An explanation of reading failure? *Cognitive Neuropsychology*, 9(1), 47-72.
- Hsieh, H. F. & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research*, 15(9), 1277-1288.
- Hsu-Min Chiang, & Yueh-Hsien Lin. (2007). Reading comprehension instruction for students with autism spectrum disorders: A review of the literature. *Focus on Autism & Other Developmental Disabilities*, 22(4), 259-267.
- Hynan, A., Murray, J., & Goldbart, J. (2014). 'Happy and excited': Perceptions of using digital technology and social media by young people who use augmentative and alternative communication. *Child Language Teaching and Therapy*, 30(2), 175-186.
- Inal, Y. & Cagiltay, K. (2007). Flow experiences of children in an interactive social game environment. *British Journal of Educational Technology*, 38(3), 455-464.
- Irwin, D.L., Pannbacker, M. & Lass, N.J. (2008). *Clinical research methods in speech language pathology and audiology*. San Diego: Plural Publishing Inc.
- Isbell, R., Sobol, J., Lindauer, L. & Lowrance, A. (2004). The effects of storytelling and story reading on the oral language complexity and story comprehension of young children. *Early Childhood Education Journal*, 32(3), 157-163.
- Johnson-Glenberg, M.C. (2000). Training reading comprehension in adequate decoders/poor comprehenders: Verbal versus visual strategies. *Journal of Educational Psychology*, 92, 772-782.
- Johnson, R., Mims-Cox, S.J. & Doyle-Nichols, A. (2006). *Developing portfolios in education*. Thousand Oaks, CA: Sage.

- Jordaan, H. (2011). Language teaching is no panacea: A theoretical perspective and critical evaluation of language in education within the South African context. *South African Journal of Communication Disorders*, 58, 79-85.
- Kame'enui, E.J. & Simmons, D.C. (2001). Introduction to this special issue: The DNA of reading fluency. *Scientific Studies of Reading*, 5(3), 203-210.
- Kathard, H., Ramma, L., Pascoe, M., Jordaan H., Moonsamy, S., Wium, A.M., du Plessis, A., Pottas, L., & Kahn, N.B. (2011). How can speech-language therapists and audiologists enhance language and literacy outcomes in South Africa? (And why we urgently need to). *South African Journal of Communication Disorders*, 58, 59-71.
- Kennedy, E. & Flynn, M. (2003). Early phonological awareness and reading skills in children with Down syndrome. *Down Syndrome Research and Practice*, 8(3), 100-109.
- King, A. M., Thomeczek, M., Voreis, G., & Scott, V. (2014). iPad® use in children and young adults with Autism Spectrum Disorder: An observational study. *Child Language Teaching and Therapy*, 30(2), 159-173.
- LaBerge, D. & Samuels, S.J. (1974). Toward a theory of automatic information processing in reading. *Cognitive Psychology*, 6, 293-323.
- Lane, K., Wolery, M., Reichow, B. & Rogers, L. (2007). Describing baseline conditions: suggestions for study reports. *Journal of Behavioural Education*, 16, 224-234.
- Lemons, C. J., & Fuchs, D. (2010). Phonological awareness of children with Down syndrome: Its role in learning to read and the effectiveness of related interventions. *Research in Developmental Disabilities*, 31(2), 316-330.

- Lervag, A. & Hulme, C. (2009). Rapid automatized naming (RAN) taps a mechanism that places constraints on the development of early reading fluency. *Psychological Science (Wiley-Blackwell)*, 20(8), 1040-1048.
- Lewis, F. (2004, winter). Speech therapists in schools: Curriculum integration and curriculum innovation – challenges to the school speech-language therapist of today. *Communiphon*, 337, 36-37.
- Logan, L. R., Hickman, R. R., Harris, S. R., & Heriza, C. B. (2008). Single-subject research design: recommendations for levels of evidence and quality rating. *Developmental Medicine and Child Neurology*, 50(2), 99-103.
- Long, T., & Johnson, M. (2000). Rigour, reliability and validity in qualitative research. *Clinical Effectiveness in Nursing*, 4(1), 30-37.
- Lonigan, C.J., Anthony, J.L., Bloomfield, B.G., Dyer, S.M. & Samwel, C.S. (1999). Effects of two shared-reading interventions on emergent literacy skills of at-risk preschoolers. *Journal of Early Intervention*, 22(4), 306-322.
- Lonigan, C. J., & Whitehurst, G. J. (1998). Relative efficacy of parent and teacher involvement in a shared-reading intervention for preschool children from low-income backgrounds. *Early Childhood Research Quarterly*, 17, 265-292.
- Lundberg, I., & Høien, T. (1991). Initial enabling knowledge and skills in reading acquisition: Print awareness and phonological segmentation. In D.J. Sawyer & B.J. Fox (Eds.), *Phonological Awareness in Reading*, (pp. 73-95). New York: Springer.
- Maphalala, Z., Pascoe, M. & Smouse, M. (2014). Phonological development of first language isiXhosa-speaking children aged 3;0- 6;0 years: a descriptive cross-sectional study. *Clinical Linguistics and Phonetics*, 28(3), 176-194.

- Martin, N. & Brownell, R. (2005). *Test of Auditory Processing Skills (3rd ed.)*.
Novato, CA: Academic Therapy Publications.
- McCoach, D.B., O'Connell, A.A., Reis, S.M. & Levitt, H.A. (2006). *Journal of Educational Psychology*, 98(1), 14-28.
- McGee, A., & Johnson, H. (2003). The effect of inference training on skilled and less skilled comprehenders. *Educational Psychology*, 23, 49–59.
- McNeill, B. C., Gillon, G. T., & Dodd, B. (2009). Effectiveness of an integrated phonological awareness approach for children with childhood apraxia of speech (CAS). *Child Language Teaching & Therapy*, 25(3), 341-366.
- Miller, T., & Bell, L. (2002). Consenting to what? Issues of access, gate-keeping and 'informed' consent. *Ethics in qualitative research*, 53-69.
- Mishna, F., Antle, B. J., & Regehr, C. (2004). Tapping the perspectives of children emerging ethical issues in qualitative research. *Qualitative Social Work*, 3(4), 449-468.
- Mitchell, M and Jolley, J (2013). *Research design explained*. Belmont, USA: Wadsworth Cengage Learning.
- Moriarty, B.C. & Gillon, G.T. (2005). Phonological awareness intervention for children with childhood apraxia of speech. *International Journal of Language and Communication Disorders*, 41(6), 713-734.
- Morse, J. M., Barrett, M., Mayan, M., Olson, K., & Spiers, J. (2008). Verification strategies for establishing reliability and validity in qualitative research. *International Journal of Qualitative Methods*, 1(2), 13-22.

- Nation, K., Clarke, P., Marshall, C. M., & Durand, M. (2004). Hidden language impairments in children: Parallels between poor reading comprehension and specific language impairment? *Journal of Speech, Language & Hearing Research, 47*(1), 199-211.
- Nation, K., Cocksey, J., Taylor, J. S. H., & Bishop, D. V. M. (2010). A longitudinal investigation of early reading and language skills in children with poor reading comprehension. *Journal of Child Psychology & Psychiatry, 51*(9), 1031-1039.
- Nation, K. & Norbury, C.F. (2005). Why reading comprehension fails: Insights from developmental disorders. *Topics in Language Disorders, 25*(1), 21.
- Nation, K. & Snowling, M.J. (1998). Semantic processing and the development of word recognition skills: Evidence from children with reading comprehension difficulties. *Journal of Memory and Language, 39*, 85-101.
- Nation, K., & Snowling, M. J. (2004). Beyond phonological skills: Broader language skills contribute to the development of reading. *Journal of Research in Reading, 27*(4), 342-356.
- Nation, K., Snowling, M.J. & Clarke, P. (2007). Dissecting the relationship between language skills and learning to read: Semantic and phonological contributions to new vocabulary learning in children with poor reading comprehension. *Advances in Speech-Language Pathology, 9*(2), 131-139.
- Navsaria, I., Pascoe, M. & Kathard, H. (2011). 'It's not just the learner, it's the system!' Teachers' perspectives on written language difficulties: Implications for speech-language therapy. *South African Journal of Communication Disorders, 58*, 95-104.
- Neale, M. D. (1997). *Neale Analysis of Reading Ability – Revised*. Windsor: NFER Nelson.

- Norris, D. (1994). A quantitative multiple-levels model of reading aloud. *Journal of Experimental Psychology: Human Perception and Performance*, 20(6), 1212-1232.
- Norton, E.S. & Wolf, M. (2012). Rapid automatized naming and reading fluency: Implications for understanding and treating reading disabilities. *Annual Review of Psychology*, 63, 427 – 52.
- Oakhill, J.V. (1982). Constructive processes in skilled and less skilled comprehenders' memory for sentences. *British Journal of Psychology*, 73, 13-20.
- Oakhill, J. V., Cain, K., & Bryant, P. E. (2003). The dissociation of word reading and text comprehension: Evidence from component skills. *Language and Cognitive Processes*, 18(4), 443-468.
- Oakhill, J.V., & Patel, S. (1991). Can imagery training help children who have comprehension problems? *Journal of Research in Reading*, 14, 106–115.
- Oakhill, J.V., Yuill, N.M. & Parkin, A. (1986). On the nature of the differences between skilled and less skilled comprehenders. *Journal of Research in Reading*, 9, 80-91.
- O'Connor, I. M., & Klein, P. D. (2004). Exploration of strategies for facilitating the reading comprehension of high-functioning students with autism spectrum disorders. *Journal of Autism & Developmental Disorders*, 34(2), 115-127.
- O'Connor, J. & Geiger, M. (2009). Challenges facing primary school educators of English second (or other) language learners in the Western Cape. *South African Journal of Education*, 29, 253-269.

- O'Connor, R.E., Fulmer, D., Harty, K., & Bell, K. (2005). Layers of reading intervention in kindergarten through third grade: Changes in teaching and child out- comes. *Journal of Learning Disabilities*, 38(5), 440-455.
- O'Connor, R.E., Harty, K.& Fulmer, D. (2005). Tiers of intervention in kindergarten through third grade. *Journal of Learning Disabilities*, 38(6), 532-538.
- Onwuegbuzie, A. J., & Leech, N. L. (2007a). A call for qualitative power analyses. *Quality & Quantity*, 41(1), 105-121.
- Onwuegbuzie, A. J., & Leech, N. L. (2007b). Validity and qualitative research: An oxymoron? *Quality & Quantity*, 41(2), 233-249.
- Orb, A., Eisenhauer, L., & Wynaden, D. (2001). Ethics in qualitative research. *Journal of Nursing Scholarship*, 33(1), 93-96.
- Owens, R.E. (2002). *Language development: An introduction* (5th ed.). Boston: Allyn & Bacon.
- Palincsar, A.S., & Brown, A.L. (1984). Reciprocal teaching of comprehension fostering and comprehension-monitoring activities. *Cognition and Instruction*, 1, 117-175.
- Paris, S.G. & Hamilton, E.E. (2009). The development of children's reading comprehension. In S. E. Israel & G.G. Duffy (Ed.), *Handbook of research on reading comprehension*, (pp. 32-53). New York: Routledge.
- Parker, R.I., Cryer, J. & Byrns, G. (2006). Controlling baseline trend in single-case research. *School Psychology Quarterly*, 21(4), 418-443.
- Pascoe, M. (2004). *Investigating intervention: Phonological therapy in a psycholinguistic framework*. (PhD, The University of Sheffield, UK).

- Pascoe, M., Harty, M. & Le Roux, J. (in press, 2014). Language, Literacy and Learning in the Classroom. Chapter in, S. Moonsamy & H. Kathard (Eds), *Speech-Language Therapists and Audiologists in a School Context: Principles and Practices*. Pretoria: Van Schaik.
- Pascoe, M., Stackhouse, J. & Wells, B. (2006). *Persisting speech difficulties in children: Children's speech and literacy difficulties 3*. Chichester: Wiley Ltd.
- Penn, C. (2007). 'Don't give me the theory, just tell me what to do in therapy!': The slippery slope challenge for the South African professions of speech-language pathology and audiology. *South African Journal of Communication Disorders*, 54, 13-17.
- Perfetti, C. A. (1977). Language comprehension and fast decoding: Some psycholinguistic prerequisites for skilled reading comprehension. In J. T. Guthrie (Ed.), *Cognition, curriculum and comprehension*. Newark, DE: International Reading Association.
- Perfetti, C. A., Landi, N., & Oakhill, J. V. (2005). The acquisition of reading comprehension skill. In M. J. Snowling & C. Hulme (Eds.), *The science of reading*. Oxford, UK: Blackwell.
- Perfetti, C. A., & Hogaboam, T. (1975). The relationship between single word decoding and reading comprehension skill. *Journal of Educational Psychology*, 67, 461-469.
- Perkins, K. (2001). Do syllable count and word frequency differ significantly in easy and difficult reading comprehension items? In M. S. Plakhotnik, S. M. Nielsen, & D. M. Pane (Eds.), *Proceedings of the Tenth Annual College of Education & GSN Research Conference* (pp. 177-182). Miami: Florida International University.

- Perry, C., Ziegler, J.C. & Zorzi, M. (2007). Nested incremental modeling in the development of computational theories: The CDP+ model of reading aloud. *Psychological Review*, 114(2), 273-315.
- Pinker, S. (1994). *The language instinct*. New York, NY: Harper Perennial Modern Classics.
- Pinto, M. & Gardner, H. (2014). Communicative interaction between a non speaking child with cerebral palsy and her mother using an iPad®. *Child Language Teaching and Therapy*, 30(2), 207-220.
- Rack, J.P., Snowling, M.J. & Olson, R.K. (1992). The nonword reading deficit in developmental dyslexia: A review. *Reading Research Quarterly*, 27(1), 28-53.
- Rastle, K., & Coltheart, M. (1999). Serial and strategic effects in reading aloud. *Journal of Experimental Psychology: Human Perception and Performance*, 25, 482-503.
- Ratner, N. B. (2006). Evidence-based practice: an examination of its ramifications for the practice of speech-language pathology. *Language, Speech, and Hearing Services in Schools*, 37(4), 257-267.
- Raymer, A. M., Thompson, C. K., Jacobs, B., & Le Grand, H. R. (1993). Phonological treatment of naming deficits in aphasia: Model-based generalization analysis. *Aphasiology*, 7(1), 27-53.
- Read, C., Zhang, Y., Nie, H., & Ding, B. (1986). The ability to manipulate speech sounds depends on knowing alphabetic spelling. *Cognition*, 24, 31-44.
- Richards, H. M., & Schwartz, L. J. (2002). Ethics of qualitative research: are there special issues for health services research? *Family Practice*, 19(2), 135-139.

- Riley, D.A. & Roach, M.A. (2006). Helping teachers grow: toward theory and practice of an 'emergent curriculum' model of staff development. *Early Childhood Education Journal*, 33(5), 363-370.
- Robertson, C. & Salter, W. (2007). Phonological Awareness Test 2. East Moline, IL: LinguiSystems.
- Robey, R. R., & Schultz, M. C. (1998). A model for conducting clinical outcome research: An adaptation of then standard protocol for use in aphasiology. *Aphasiology*, 12, 787-810.
- Roman, A.A., Kirby, J.R., Parrila, R.K., Wade-Woolley, L. & Deacon, S.H. (2009). Towards a comprehensive view of the skills involved n word reading in grades 4, 6 and 8. *Journal of Experimental Child Psychology*, 102(1), 96-113.
- Roschelle, J., Tatar, D., Chaudbury, S., Dimitriadis, Y., Patton, C., & DiGiano, C. (2007). Ink, improvisation, and interactive engagement: Learning with tablets. *Computer*, 40(9), 42-48.
- Roth, F. P., & Worthington, C. K. (2010). *Treatment resource manual for speech-language pathology*. Delmar: Cengage Learning.
- Rummelhart, D. E. (1994). Towards an interactive model of reading. In R. B. Ruddel, M. Rapp-Ruddel, & H. Singer (Eds.), *Theoretical models and processes of reading*, 4th ed., (pp. 864-894). Newark, DE: International Reading Association.
- Sabatini, J., Albro, E., & O'Reilly, T. (2012). *Measuring Up: Advances in How We Assess Reading Ability*. Maryland: Rowman & Littlefield Education.
- Schmitt, M. B., & Justice, L. M. (2012). Optimal intervention intensity for emergent literacy: What we know and need to learn. *International Journal of Speech-Language Pathology*, 14(5), 451-455.

- Seidenberg, M. S., & McClelland, J. L. (1989). A distributed developmental model of word recognition and naming. *Psychological Review*, 96, 523–568.
- Semel, E., Wiig, E. H & Secord, W. A.. (2003). Clinical evaluation of language fundamentals (4th ed.). San Antonio, TX: The Psychological Corporation.
- Siegel, L. (1988). Evidence that IQ scores are irrelevant to the definition and analysis of reading disability. *Canadian Journal of Psychology*, 42, 201–215.
- Silverman, D. (2010). *Qualitative research*. London: Sage Publications Limited.
- Simos, P. G., Fletcher, J. M., Foorman, B. R., Francis, D. J., Castillo, E. M., Davis, R. N., et al. (2002). Brain activation profiles during the early stages of reading acquisition. *Journal of Child Neurology*, 17, 159–163.
- Snowling, M., & Stackhouse, J. (2006). *Dyslexia, speech and language: A practitioner's handbook*. West Sussex: Whurr Publishers Ltd.
- Snowling, M. J., & Hulme, C. (2012). Interventions for children's language and literacy difficulties. *International Journal of Language & Communication Disorders*, 47 (1), 27–34.
- Sobol, J. D. (1992) Innervision and innertext: Oral traditional and oral interpretive modes of story performance. *Oral Tradition* 7(1), 66–86.
- Spear-Swerling, L. & Sternberg, R.J. (1994). The road not taken: An integrative theoretical model of reading disability. *Journal of Learning Disabilities*, 27(2), 91-103.
- Stackhouse, J. & Wells, B. (1997). *Children's speech and literacy difficulties 1: A psycholinguistic framework*. London: Whurr Publishers.

- Stackhouse, J. & Wells, B. (2001). *Children's speech and literacy difficulties 2: Identification and intervention*. London: Whurr Publishers.
- Stackhouse, J., Wells, B., Pascoe, M., & Rees, R. (2002). From phonological therapy to phonological awareness. *Seminars in Speech and Language*, 23 (1), 23-34.
- Stanovich, K. (1980). Toward an interactive-compensatory model of individual differences in the development of reading fluency. *Reading Research Quarterly*, 16 (1), 32-71.
- Stanovich, K. E. (1986). Cognitive processes and the reading problems of learning disabled children: Evaluating the assumption of specificity. In J. K. Torgesen & B. Wong (Eds.), *Psychological and educational perspectives on learning disabilities*. San Diego, CA: Academic Press.
- Stanovich, K. E. (1991). Discrepancy definitions of reading disability: Has intelligence led us astray? *Reading Research Quarterly*, 26, 7-29.
- Stanovich, K. E., & Siegel, L. S. (1994). Phenotypic performance profile of children with reading disabilities: A regression-based test of the phonological-core variable-difference model. *Journal of Educational Psychology*, 86, 24-53.
- Strattman, K., & Hodson, B. W. (2005). Variables that influence decoding and spelling in beginning readers. *Child Language Teaching and Therapy*, 21(2), 165-190.
- Sutherland, D., & Gillon, G. T. (2007). Development of phonological representations and phonological awareness in children with speech impairment. *International Journal of Language and Communication Disorders*, 42(2), 229-250.

- Tan, A. & Nicholson, T. (1997). Flashcards revisited: training poor readers to read words faster improves their comprehension of text. *Journal of Educational Psychology*, 89(2), 276-288.
- Tan, L.H., Spinks, J.A., Eden, G.F., Perfetti, C.A. & Siok, W.T. (2005). Reading depends on writing, in Chinese. *Proceedings of the National Academy of the United States of America*, 102(24), 8781–8785.
- Tate., L., Mcdonald, R., Perdices, M., Togher, L., Schultz, R. & Savage, S. (2008). Rating the methodological quality of single-subject designs and n-of-1 trials: Introducing the Single-Case Experimental Design (SCED) Scale. *Neuropsychological Rehabilitation*, 18(4), 385-401.
- Togher, L. (2012). Challenges inherent in optimizing speech-language pathology outcomes: It's not just about counting the hours. *International Journal of Speech-Language Pathology*, 15(5), 438-442.
- Torgesen, J. K., Rashotte, C. A., & Alexander, A. W. (2001). Principles of fluency instruction in reading: Relationships with established empirical outcomes. In M. Wolf (Ed.), *Dyslexia, fluency, and the brain*. Timonium, MD: York Press.
- Van Bysterveldt, A. K., Gillon, G. T., & Moran, C. (2006). Enhancing phonological awareness and letter knowledge in preschool children with Down syndrome. *International Journal of Disability: Development and Education*, 53(3), 301-329.
- Van Staden, S., & Howie, S. (2012). South African teacher profiles and emerging teacher factors: The picture painted by PIRLS 2006. *Reading & Writing*, 1(1).
- Vance, M. & Clegg, J. (2012). Use of single case study research in child speech, language and communication interventions. *Child Language Teaching Therapy*, 28(3), 255-258.

- Vance, M. & Clegg, J. (2014). Editorial. *Child Language Teaching Therapy*, 30(2), 139-140.
- Vygotsky, L.S. (1978). *Mind in society: the development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- Warren, S. F., Fey, M. E., & Yoder, P. J. (2007). Differential treatment intensity research: A missing link to creating optimally effective communication interventions. *Mental Retardation & Developmental Disabilities Research Reviews*, 13(1), 70-77.
- Webb, V.A., Lafon, M., & Pare, P. (2010). Bantu languages in education in South Africa: Ongekho akekho! The absentee owner. *Language Learning Journal*, 37(3), 273-292.
- Whitehurst, G. J., Arnold, D. S., Epstein, J. N., Angell, A. L., Smith, M., & Fischel, J. E. (1994). A picture book reading intervention in day care and home for children from low-income families. *Developmental Psychology*, 30(5), 679-689.
- Whittemore, R., Chase, S. K., & Mandle, C. L. (2001). Validity in qualitative research. *Qualitative Health Research*, 11(4), 522-537.
- Williams, L., McLeod, S. & McCauley, R. (Eds). (2010). *Speech Sound Difficulties in Children*. Brookes: USA.
- Wimmer, H., Landerl, K., & Frith, U. (1999). Learning to read German: Normal and impaired acquisition. In M. Harris & G. Hatano (Eds), *Learning to read and write: A cross-linguistic perspective*, (pp. 34-50). Cambridge: Cambridge University Press.
- Wium, A.M. & Louw, B. (2011). Teacher support – an exploration of how

- foundation-phase teachers facilitate language skills. *South African Journal of Communication Disorders*, 58(2), 86-94.
- Wium, A.M. & Louw, B. (2013). Revisiting the roles and responsibilities of speech-language therapists in South African schools. *South African Journal of Communication Disorders*, 60, 31-37.
- Wolf, M. (2008). *Proust and the squid: The story and science of the reading brain*. New York: HarperCollins Publishers.
- Wolf, M., Ullman-Shade, C. & Gottwald, S. (2012). The emerging, evolving reading brain in a digital culture: Implications for new readers, children with reading difficulties, and children without schools. *Journal of Cognitive Education and Psychology*, 11(3), 230 – 240.
- Yuill, N., & Joscelyne, T. (1988). Effect of organizational cues and strategies on good and poor comprehenders' story understanding. *Journal of Educational Psychology*, 80, 152–158.
- Yuill, N., & Oakhill, J.V. (1988). Effects of inference training on poor reading comprehension. *Applied Cognitive Psychology*, 2, 33–45.
- Zeng, B., Law, J., & Lindsay, G. (2012). Characterizing optimal intervention intensity: The relationship between dosage and effect size in interventions for children with developmental speech and language difficulties. *International Journal of Speech-Language Pathology*, 14(5), 471-477.
- Ziegler, J. C., Perry, C., & Coltheart, M. (2000). The DRC model of visual word recognition and reading aloud: An extension to German. *European Journal of Cognitive Psychology*, 12, 413–430.

Ziegler, J. C., Perry, C., & Coltheart, M. (2003). Speed of lexical and nonlexical processing in French: The case of the regularity effect. *Psychonomic Bulletin and Review*, 10, 947–953.

Zorzi, M., Houghton, G. & Butterworth, B. (1998). Two routes or one in reading aloud? A connectionist dual-process model. *Journal of Experimental Psychology: Human Perception and Performance*, 24(4), 1131-1161.

APPENDICES:

Appendix A: Permission letter: The Western Cape Department of Education (WCDE)



School of Health and Rehabilitation Sciences

Faculty of Health Sciences

Divisions of Communications Sciences and Disorders, Nursing and Midwifery, Occupational Therapy, Physiotherapy

F45 Old Main Building, Groote Schuur Hospital, Observatory 7925

Tel: +27 (0) 21 406 6401 Fax: +27 (0) 21 406 6323

Internet: www.uct.ac.za

Dear Sir /Madam

RE: Information about research study and consent for participation of learners

I am a Master's student in the Division of Communication Sciences and Disorders at the University of Cape Town. In order to obtain my Master's degree in Speech Language Therapy (SLT) I need to do a research project. I am interested in researching how children with reading comprehension difficulties respond to an application (app) based intervention for reading comprehension on the iPad®.

There is very limited information about how children respond to app based intervention. Such information is important in order for Speech Language Therapists, parents and educators to improve the way in which they help children with reading comprehension difficulties.

This study intends to describe the outcomes of an application (app)- based intervention for five children with reading comprehension difficulties. This study aims to contribute to the limited knowledge base on efficacy, optimal dosage and intensity of app-based intervention for children with reading comprehension difficulties. The detailed research proposal is attached.

We would need to identify five learners at schools in the Western Cape who are at a grade one reading level; and who have been identified by their SLT and educator as having reading comprehension difficulties. Once informed consent has been obtained from The Department of Education, the school principals, the parents and learners, each learner's language and literacy skills will be assessed. This may need to be conducted at the schools' premises in a quiet room or at the learners' homes and may take 2-3 sessions depending on interruptions and distractibility. This will be followed by a break of 3 – 4 weeks after which each participant will partake in 6 weeks of intervention using the Reading TherAppy and/or Comprehension TherAppy app (Tactus Therapy Solutions) on an iPad®.

Either the learner will already have access to an iPad®, or if not, the researcher will make an iPad mini® available only for the duration of the study, after which the child will be required to return it to the researcher. This intervention will require the learner to identify the written word/phrase/sentence that corresponds to a picture, or vice versa (depending on their level). The researcher will visit each participant for three times a week (at their home or school) in order to mediate sessions on the iPad® and to document all relevant information. The session times will be negotiated and every effort will be made to reduce disruptions to the pre-school schedule. Once the intervention is completed, changes will be measured and documented and each learner will be interviewed. Learners will be followed up six months after initial assessment in order to document any long-term changes to their reading comprehension or generalization.

There will be no payment if the child partakes in the study, however they will not have to pay for the intervention. The parents and learners decision to partake in the study have no bearing on the current SLT services that they are awaiting or receiving (i.e. services will continue as before).

The Department of Education will receive an annual update reflecting the research process including details of site selections. At any point in the process, the researchers will be available to discuss any aspect of concern that might arise. The final write up of results will be shared with your Department and the results will also be disseminated through academic publications. The outcomes of the project are likely to benefit educators, learners and speech-language therapists. There are no cost implications for the Department.

I hereby request permission to conduct this study in selected classrooms under jurisdiction of Western Cape Education Department.

Thank you for considering this request. Should you have any questions, please contact me or my supervisor (details below).

This project has received Ethical clearance through the Human Research Ethics Committee, Faculty of Health Sciences of the University of Cape Town
No. 483/2013

Yours faithfully,

Gaby Kaplan

Dr. Michelle Pascoe

(Researcher)
Mobile: 083 700 5878
E-mail: gabskap@gmail.com

(Research Supervisor)
Tel: 021 406 6043
Email: michelle.pascoe@uct.ac.za

Appendix B: Information letter and informed consent: School principal



**School of Health and Rehabilitation
Sciences**

Faculty of Health Sciences

**Divisions of Communications Sciences and
Disorders, Nursing and Midwifery,
Occupational Therapy, Physiotherapy**

F45 Old Main Building, Groote Schuur Hospital,
Observatory 7925

Tel: +27 (0) 21 406 6401 Fax: +27 (0) 21 406 6323

Internet: www.uct.ac.za

Dear Sir /Madam

RE: Information about research study and consent for participation of learners

I am a Master's student in the Division of Communication Sciences and Disorders at the University of Cape Town. In order to obtain my Master's degree in Speech Language Therapy (SLT) I need to do a research project. I am interested in researching how children with reading comprehension difficulties respond to an application (app) based intervention for reading comprehension on the iPad®.

There is very limited information about how children respond to app based intervention. Such information is important in order for Speech Language Therapists, parents and educators to improve the way in which they help children with reading comprehension difficulties.

This study intends to describe the outcomes of an application (app)- based intervention for five children with reading comprehension difficulties. This study aims to contribute to the limited knowledge base on efficacy, optimal dosage and intensity of app-based intervention for children with reading comprehension difficulties. The detailed research proposal is attached.

We would need to identify five learners at your school who are at a grade one reading level; and who have been identified by their SLT and educator as having reading comprehension difficulties. Once informed consent has been obtained from yourself, the parents and learners, each learner's language and literacy skills will be assessed. This may need to be conducted at your premises in a quiet room or at the learners' homes and may take 2-3 sessions depending on interruptions and distractibility. This will be followed by a break of 3 – 4 weeks after which each participant will partake in 6 weeks of intervention using the Reading TherAppy and/or Comprehension TherAppy app (Tactus Therapy Solutions) on an iPad®. Either the learner will already have access to an iPad®, or if not, the researcher will make an iPad mini® available only for the duration

of the study, after which the child will be required to return it to the researcher. This intervention will require the learner to identify the written word/phrase/sentence that corresponds to a picture, or vice versa (depending on their level). The researcher will visit each participant for three times a week (at their home or school) in order to mediate sessions on the iPad® and to document all relevant information. The session times will be negotiated and every effort will be made to reduce disruptions to the pre-school schedule. Once the intervention is completed, changes will be measured and documented and each learner will be interviewed. Learners will be followed up six months after initial assessment in order to document any long-term changes to their reading comprehension or generalization.

There will be no payment if the child partakes in the study, however they will not have to pay for the intervention. The parents and learners decision to partake in the study have no bearing on the current SLT services that they are awaiting or receiving (i.e. services will continue as before).

You will receive feedback during the research process. The researcher is available to discuss any concerns that may arise. On completion of the study, findings will be shared with your school and results will be disseminated through academic publications.

I hereby request permission to conduct this study with selected learners at your school.

Thank you for considering this request. Should you have any questions, please contact me or my supervisor (details below).

This project has received Ethical clearance through the Human Research Ethics Committee, Faculty of Health Sciences of the University of Cape Town
No. 483/2013

Yours faithfully,

Gaby Kaplan

(Researcher)
Mobile: 083 700 5878
E-mail: gabskap@gmail.com

Dr. Michelle Pascoe

(Research Supervisor)
Tel: 021 406 6043
Email: michelle.pascoe@uct.ac.za

Appendix C: Information letter and informed consent: Parents / legal guardian of learner

 The logo of the University of Cape Town, featuring a shield with a book and a torch, surrounded by the university's name in English, Afrikaans, and Xhosa.	School of Health and Rehabilitation Sciences Faculty of Health Sciences Divisions of Communications Sciences and Disorders, Nursing and Midwifery, Occupational Therapy, Physiotherapy F45 Old Main Building, Groote Schuur Hospital, Observatory 7925 Tel: +27 (0) 21 406 6401 Fax: +27 (0) 21 406 6323 Internet: www.uct.ac.za
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Dear Mr. and Mrs _____

RE: Information about research study and invitation to consent to your child's participation in a research project.

I am a Master's student in the Division of Communication Sciences and Disorders at the University of Cape Town. In order to get my Master's degree in Speech Language Therapy (SLT) I need to do a research project. I am interested in understanding more about children who find it hard to understand what they read. I want see if a therapy programme on an iPad® can help them improve their reading.

We do not yet know if this type of therapy can help children with their reading. It is important for us to find out if this can help children with their reading. It would be helpful for Speech Language Therapists, parents and educators to know more about the ways to help children with their reading.

I am inviting your child to participate in this study because he/she has been identified by the class teacher and /or Speech Language Therapist as having difficulty with reading and understanding what s/he is reading. I will work individually with five children who are able to read at least at a grade 1 reading level.

I would first need to assess your child's reading and language skills. I will do this using speech, language and reading assessments used by Speech and Language therapists to evaluate your child's spoken and written language. Your child will be asked to identify pictures, describe pictures and to read/spell some words. The assessments will be carried out at your convenience at your child's home or school and should take no longer than two or three hours depending on how well your child can concentrate. Another brief, follow up assessment (30 minutes

each) would then be carried out. This will be followed by a break of 3 – 4 weeks after which therapy will commence.

The therapy would be carried out by the researcher at your home or the child's school. I will provide a computer based therapy programme that is appropriate for your child's level of reading ability. This programme will require your child to read words and look at pictures on the iPad® / computer. I will be there to support your child and help with any difficulties. I will provide an iPad mini® which I will bring with me on each visit. This will only be available for the duration of the study. The therapy will be for 6 weeks, during which I would need to visit your child three times a week for half hour sessions, either at your home or at school.

After the therapy is finished, I would need to carry out some more assessments with your child and interview him / her to find out what s/he thought about the therapy. Your child will be followed up again for a final assessment six months later in order to evaluate progress. The findings of the study will be analyzed and used by the research team to write a research report. The researcher may need to contact you for more information about your child's development.

Participation in this study is voluntary. If you, or your child, wish to withdraw from the study, you may do so at any time without having to provide a reason. Your decision to partake in the study will have no bearing on the speech language therapy services that your child is currently waiting for or receiving (i.e. services will continue as planned). I will ensure that all identifying information (e.g. your child's name, address) is known only to the research team and it will not be included in any research reports, presentations or discussions that arise from the study. Each learner will be given a coded name in order to ensure confidentiality.

There are no risks in taking part in this study and there will not be any rewards for taking part in the study. Your child's reading and / or language may benefit from the intervention and children usually enjoy carrying out these activities. You or your child will not receive payment for being in the study. You will not need to pay for the intervention.

You will receive feedback once the study has been completed and if the researcher discovers that your child has any additional difficulties, they would be referred to a professional who could help support them.

Thank you for considering this request. Please find the consent form attached. Should you have any questions, please contact me or my supervisor (details below). This study has approval from the University of Cape Town Faculty of Health Sciences Human Research Ethics Committee (Reference number: 483/2013). The University of Cape Town Faculty of Health Sciences Human Research Ethics Committee can be contacted if you have any queries about your rights and welfare as the parent / legal guardian of the child participant: 021 406 6496 or at the Old Main Building of Groote Schuur Hospital, Floor E52, Room 23, Observatory, 7925.

Yours faithfully

Gaby Kaplan

(Researcher)

Mobile: 083 700 5878

E-mail: gabskap@gmail.com

Dr. Michelle Pascoe

(Research Supervisor)

Tel: 021 406 6043

Email: michelle.pascoe@uct.ac.za

Title: App based intervention for children with reading comprehension difficulties: A description of 5 cases

I, _____ have read (or had read to me by _____) the Information Sheet. I understand what is required of my child. I **do/do not** consent to his/her participation in the study (circle if applicable). All of my questions have been answered. I do not feel that myself or my child are forced to take part in this study and I am doing so of my own free will. I know that I can withdraw at any time if I so wish and that it will have no bad consequences for me or my child.

Signed:

Parent/Legal Guardian 1

Date and place

Parent /Legal Guardian 2

Date and place

Gaby Kaplan

Dr. Michelle Pascoe

(Researcher)
Mobile: 083 700 5878
E-mail: gabskap@gmail.com

(Research Supervisor)
Tel: 021 406 6043
Email: michelle.pascoe@uct.ac.za

The University of Cape Town Faculty of Health Sciences Human Research Ethics Committee can be contacted if you have any queries about your rights and welfare as the parent of the child participant: 021 406 6496 or at the Old Main Building of Groote Schuur Hospital, Floor E52, Room 23, Observatory, 7925.

Appendix D: Assent form for participants

	School of Health and Rehabilitation Sciences Faculty of Health Sciences Divisions of Communications Sciences and Disorders, Nursing and Midwifery, Occupational Therapy, Physiotherapy F45 Old Main Building, Groote Schuur Hospital, Observatory 7925 Tel: +27 (0) 21 406 6401 Fax: +27 (0) 21 406 6323 Internet: www.uct.ac.za
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I am Gaby Kaplan and I want to tell you about a research study I am doing. A research study is a way to learn more about something. We would like to find out more about how the iPad® can help children understand what they read. We have asked you to join this study because your teacher/parent has told me that you sometimes find it difficult to read. I have already asked your parents / guardian if it is OK for you join this study and they have said yes – but you can say no if you do not want to do it.

I would first need to find out a bit more about how you read, write and talk. I would do this by showing you pictures in books and asking you to say what they are if you can; I would ask you to listen to some things I say and show me pictures, and ask you to do some reading and writing similar to what you do in your classroom at school. I would either come to your house or visit you at school. I would need to visit you a few times to do all of this. It will probably take about 2 or 3 hours (a whole afternoon) but we can split up the time so that you do not get too tired.

After that I will have the iPad® ready to show you. I will come and visit you at home or school three times each week for half an hour each time. You can read words and look at pictures on the iPad®. I will be there to help you if you get stuck.. I will bring the iPad® each time but after the study stops I would not be able to bring it again. I will visit you for about 6 weeks (almost a whole school term).

After we are finished with the iPad® I will need to do some more of the tasks like I did at the start of the study using books and pictures and asking you to write with a pencil and paper. I would also like to chat to you to find out if you liked the iPad® game or if you did not. I will come and visit you next year to see how you are doing and I will ask you to do some reading and spelling using a pencil and paper.

You can decide if you would like to take part. If you say yes, you can stop at any time. You can ask me any questions you have about the study.

When I describe the study to other people or write up my project I will not use your name. You can chose a pretend name or I can use your initials so that nobody will know who you are or what you said or did. There are no prizes for taking part in this, but it might help your reading. You may like the computer games and using the iPad®. The study is very safe.

Please circle the first sentence if you would like to be part of this study, or circle the second sentence if you would not like to be part of it.

Yes, I will be in this research study.

No, I don't want to do this.

Child's name

Signature of the child

Date

Person obtaining Assent

Signature

Date

Gaby Kaplan

Dr. Michelle Pascoe

(Researcher)

Mobile: 083 700 5878

E-mail: gabskap@gmail.com

(Research Supervisor)

Tel: 021 406 6043

Email: michelle.pascoe@uct.ac.za

The University of Cape Town Faculty of Health Sciences Human Research Ethics Committee can be contacted if you have any queries about your rights and welfare as the parent of the child participant: 021 406 6496 or at the Old Main Building of Groote Schuur Hospital, Floor E52, Room 23, Observatory, 7925.

Appendix E: List of standardized assessment tools

1. Clinical Evaluation of Language Fundamentals Fourth Edition (CELF 4) (Semel, Wiig & Secord, 2003)
2. Test of Auditory Processing Skills Third Edition (TAPS 3) (Martin & Brownell, 2005)
3. Phonological Awareness Test 2 (PAT 2) (Robertson & Salter, 2007)
4. ESSI Reading and Spelling Test (Esterhuyse & Beukes, 1997)
5. Neale Analysis of Reading Ability Second Revised Edition (Neale, 1997).
6. Edinburgh Articulation Test (Anthony, Bogle, Ingram & McIsaac, 1971).

Appendix F: The Intervention Fidelity Checklist for participants/caregivers/educators and researcher

Section A

The following questions are to be administered to the participant/caregivers/educators before each session, particularly if the child already has access to an iPad® at home or at school:

- Did the participant use the iPad® at any other times besides the intervention?
- If so, what apps did they use?
- Did they use the intervention app during other times (besides for the mediated intervention)?
- If so, approximately how often/for how long did they play with each app?
- Did they play with the app independently, or did they receive assistance/monitoring from someone else (i.e parent/teacher/sibling/friend)?

Section B

The following information should be documented after (and during if necessary) the intervention session:

Environmental factors:

- Was there background noise/disturbance during the session (i.e. TV, music, shouting or talking)?
- Where was the intervention conducted? (school room, child's home)
- If this the session was conducted at home, did the parents siblings participate or interrupt?

Behavioural factors:

- Was the child able to maintain appropriate attention throughout the session?
- If not, describe their attention.
- If not, what may have contributed to this?
- Describe the child's behavior during the session
- What may have contributed to this?

Appendix G: Ethical clearance letter

UNIVERSITY OF CAPE TOWN



Faculty of Health Sciences
Faculty of Health Sciences Human Research Ethics Committee
Room E52-24 Groote Schuur Hospital Old Main Building
Observatory 7925
Telephone [021] 406 6338 • Facsimile [021] 406 6411
e-mail: sumayah.ariefdien@uct.ac.za
www.health.uct.ac.za/research/humanethics/forms

15 August 2013

HREC REF: 483/2013

Dr M Pascoe
Health & Rehab Sciences
F-floor
OMB

Dear Dr Pascoe

PROJECT TITLE: APP-BASED INTERVENTION FOR CHILDREN WITH READING COMPREHENSION DIFFICULTIES: A DESCRIPTION OF FIVE CASES

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee for review.

It is a pleasure to inform you that the HREC has **formally approved** the above mentioned study.

Approval is granted for one year till the 28 August 2014.

Please submit a progress form, using the standardised Annual Report Form, if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.

Please note that the on-going ethical conduct of the study remains the responsibility of the principal investigator.

Please quote the REC. REF in all your correspondence.

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, HSF HUMAN ETHICS

Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IRB00001938

This serves to confirm that the University of Cape Town Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA),
sAriefdien

Appendix H: Child G's pre intervention assessment results, probe items and post intervention assessment results

1. Pre intervention standardized assessment results:

- Behaviour during assessment:
Child G co-operated well in all assessment tasks. However, at times he seemed to respond impulsively (that is, responding quickly, without paying full attention to the question/item).
- Receptive and expressive language components were evaluated using The Clinical Evaluation of Language Fundamentals Fourth Edition (CELF 4) (Semel, Wiig & Secord, 2003).

CELF 4 SUBTEST	PERCENTILE RANK*	INTERPRETATION
Concepts and following directions	<1	Significantly below average
Word structure	2	Significantly below average
Recalling sentences	9	Below average
Formulated sentences	2	Significantly below average
Word classes - receptive	5	Below average
Word classes - expressive	5	Below average
Sentence structure	25	Low average
Expressive vocabulary	<1	Significantly below average
Understanding spoken paragraphs	2	Significantly below average
Number repetition - forward	37	Average
Number repetition - backward	91	Above average
Number repetition - total	63	Average
Word associations	n/a	Normal
Rapid automatic naming (RAN) - time	n/a	Normal
Rapid automatic naming (RAN) - errors	n/a	Normal

*16 – 84 = average range

- Phonological awareness was evaluated using the Phonological Awareness Test 2 (PAT 2) (Robertson & Salter, 2007).

SUBTEST	PERCENTILE RANK*	INTERPRETATION
Rhyming: Discrimination Production Total	16 2 2	Borderline low average Significantly below average Significantly below average
Segmentation: Sentences Syllables Phonemes Total	26 17 61 21	Average Average Average Average
Isolation: Initial Final Medial Total	69 51 39 52	Average Average Average Average
Deletion: Compounds & syllables Phonemes Total	14 38 24	Below average Average Average
Substitution: With manipulatives Without manipulatives Total	58 31 48	Average Average Average
Blending: Syllables Phonemes Total	6 17 11	Below average Low average Below average
Graphemes: Consonants Long & short vowels Consonant blends Consonant digraphs R-controlled vowels Vowel digraphs Diphthongs Total	24 47 33 19 75 29 <49 33	Average Average Average Average Average Average Average Average

Decoding:		
VC words	66	Average
CVC words	63	Average
Consonant digraphs	50	Average
Consonant blends	33	Average
Vowel digraphs	28	Average
R-controlled vowels	48	Average
CVCe words	<26	-
Diphthongs	52	Average
Total	64	Average
TOTAL TEST	42	Average

- Reading of sight words and spelling of single words was assessed using the ESSI Reading and Spelling Test (Esterhuyse & Beukes, 1997). Results were as follows:

SUBTEST	PERCENTILE RANK*	INTERPRETAION
Reading of sight words	23	Average
Spelling of single words	n/a	Did not pass screener

- Rate, accuracy and comprehension of oral reading was evaluated using the Neale Analysis of Reading Ability 2nd Revised Edition (Neale, 1997). Results were as follows:

SUBTEST	PERCENTILE RANK*	INTERPRETATION
Accuracy	20	Average
Comprehension	30	Average
Rate	20	Average

- Speech production was evaluated using the Edinburgh Articulation Test (Anthony, Bogle, Ingram & McIsaac, 1971). Child G often substituted “th” for /f/ in all word positions. However it is likely that this is dialectal, as he is a first language French speaker.

2. Treated (List A) and untreated (List B) probe results at t1 (pre intervention phase), t2 (baseline period) and t3 (post intervention phase):

- Single word reading level on Comprehension TherAppy app (Tactus Therapy Solutions)

	LIST A	LIST B
T1	12%	12%
T2	52%	55%
T3	100%	80%

- Phrase word reading level on Reading TherAppy app (Tactus Therapy Solutions)

	LIST A	LIST B
T1	10%	10%
T2	60%	60%
T3	96%	63%

3. Post intervention results and comparison on standardized measures

- ESSI Reading and Spelling Test (Esterhuyse & Beukes, 1997).

SUBTEST	Pre-intervention		Post-intervention	
	PERCENTILE RANK*	INTERPRETAION	PERCENTILE RANK*	INTERPRETAION
Reading of sight words	23	Average	77	Average
Spelling of single words	n/a	Did not pass screener	60	Average

- Neale Analysis of Reading Ability 2nd Revised Edition (Neale, 1997).

SUBTEST	Pre-intervention		Post-intervention	
	PERCENTILE RANK*	INTERPRETATION	PERCENTILE RANK*	INTERPRETATION
Accuracy	20	Average	30	Average
Comprehension	30	Average	18	Average
Rate	20	Average	55	Average

Appendix I: Child S' pre intervention assessment results, probe items and post intervention assessment results

1. Pre intervention standardized assessment results:

- Behaviour during assessment:
Child S co-operated well during all assessment tasks and enjoyed the positive reinforcement received at the end of every few subtests that she completed. Assessment tasks took somewhat longer to complete than expected, which may have been due to slower processing of information.
- Receptive and expressive language components were evaluated using The Clinical Evaluation of Language Fundamentals Fourth Edition (CELF 4) (Semel, Wiig & Secord, 2003).

CELF 4 SUBTEST	PERCENTILE RANK*	INTERPRETATION
Concepts and following directions	91	Above average
Word structure	9	Below average
Recalling sentences	84	Average
Formulated sentences	16	Borderline low average
Word classes - receptive	75	Average
Word classes - expressive	84	Average
Sentence structure	75	Average
Expressive vocabulary	50	Average
Understanding spoken paragraphs	25	Average
Number repetition - forward	50	Average
Number repetition - backward	91	Above average
Number repetition - total	75	Average
Word associations	n/a	Above average
Rapid automatic naming (RAN) - time	n/a	Normal
Rapid automatic naming (RAN) - errors	n/a	Normal

*16 – 84 = average range

- Auditory perceptual skills were evaluated using The Test of Auditory Processing Skills Third Edition (TAPS 3) (Martin & Brownell, 2005).

TAPS 3 SUBTEST	PERCENTILE RANK*	INTERPRETATION
Word discrimination	91	Above average
Word memory	75	Average
Auditory comprehension	75	Average
Auditory reasoning	63	Average

- Phonological awareness was evaluated using the Phonological Awareness Test 2 (PAT 2) (Robertson & Salter, 2007).

PAT 2 SUBTEST	PERCENTILE RANK*	INTERPRETATION
Rhyming: Discrimination Production Total	16 <2 2	Borderline low average Significantly below average Significantly below average
Segmentation: Sentences Syllables Phonemes Total	74 24 61 45	Average Average Average Average
Isolation: Initial Final Medial Total	12 14 29 17	Below average Below average Average Average
Deletion: Compounds & syllables Phonemes Total	83 58 73	Average Average Average
Substitution: With manipulatives Without manipulatives Total	68 31 53	Average Average Average
Blending: Syllables Phonemes Total	<2 9 3	Significantly below average Below average Significantly below average
Graphemes: Consonants Long & short vowels Consonant blends Consonant digraphs R-controlled vowels Vowel digraphs Diphthongs Total	24 83 26 70 75 29 49 46	Average Average Average Average Average Average Average Average

Decoding:		
VC words	66	Average
CVC words	92	Above average
Consonant digraphs	89	Above average
Consonant blends	43	Average
Vowel digraphs	<22	?
R-controlled vowels	71	Average
CVCe words	<26	?
Diphthongs	23	Average
Total	46	Average
TOTAL TEST	33	Average

- Reading of sight words and spelling of single words was assessed using the ESSI Reading and Spelling Test (Esterhuyse & Beukes, 1997)

ESSI SUBTEST	PERCENTILE RANK*	INTERPRETAION
Reading of sight words	60	Average
Spelling of single words	77	Average

- Accuracy and comprehension of oral reading was evaluated using the Neale Analysis of Reading Ability 2nd Revised Edition (Neale, 1997).

NARA 2 SUBTEST	PERCENTILE RANK*	INTERPRETATION
Accuracy	4	Below average
Comprehension	9	Below average

- Speech production was evaluated using the Edinburgh Articulation Test.

2. Treated (List A) and untreated (List B) probe results at t1 (pre intervention phase), t2 (baseline period) and t3 (post intervention phase):

- Single word reading level on Comprehension TherAppy app (Tactus Therapy Solutions)

	LIST A	LIST B
T1	6%	6%
T2	62%	63%
T3	98%	88%

- Phrase word reading level on Reading TherAppy app (Tactus Therapy Solutions)

	LIST A	LIST B
T1	10%	10%
T2	57%	55%
T3	98%	80%

3. Post intervention results and comparison on standardized measures:

- ESSI Reading and Spelling Test (Esterhuyse & Beukes, 1997).

SUBTEST	Pre-intervention		Post-intervention	
	PERCENTILE RANK*	INTERPRETAION	PERCENTILE RANK*	INTERPRETAION
Reading of sight words	60	Average	77	Average
Spelling of single words	77	Average	89	Above average

- Neale Analysis of Reading Ability 2nd Revised Edition (Neale, 1997).

SUBTEST	Pre-intervention		Post-intervention	
	PERCENTILE RANK*	INTERPRETATION	PERCENTILE RANK*	INTERPRETATION
Accuracy	4	Below average	30	Average
Comprehension	9	Below average	20	Average

Appendix J: Child B's pre intervention assessment results, probe items and post intervention assessment results

1. Pre intervention standardized assessment results:

- Behaviour during assessment:
Child B was an enthusiastic learner who co-operated well. Her attention and concentration was appropriate.
- Receptive and expressive language components were evaluated using The Clinical Evaluation of Language Fundamentals Fourth Edition (CELF 4) (Semel, Wiig & Secord, 2003).

CELF 4 SUBTEST	PERCENTILE RANK*	INTERPRETATION
Concepts and following directions	37	Average
Word structure	9	Below average
Recalling sentences	37	Average
Formulated sentences	9	Below average
Word classes 2 - Total	9	Below average
Sentence structure	9	Below average
Expressive vocabulary	5	Below average
Understanding spoken paragraphs	9	Below average
Number repetition - forward	50	Average
Number repetition - backward	25	Average
Number repetition - total	25	Average
Word associations	n/a	Normal
Rapid automatic naming (RAN) - time	n/a	Normal
Rapid automatic naming (RAN) - errors	n/a	Normal

*16 – 84 = average range

- Auditory perceptual skills were evaluated using The Test of Auditory Processing Skills Third Edition (TAPS 3).

TAPS 3 SUBTEST	PERCENTILE RANK*	INTERPRETATION
Word discrimination	63	Average
Word memory	16	Borderline low average
Auditory comprehension	2	Significantly below average
Auditory reasoning	37	Average

- Phonological awareness was evaluated using the Phonological Awareness Test 2 (PAT 2) (Robertson & Salter, 2007).

SUBTEST	PERCENTILE RANK*	INTERPRETATION
Rhyming: Discrimination Production Total	11 73 40	Below average Average Average
Segmentation: Sentences Syllables Phonemes Total	75 20 62 53	Average Average Average Average
Isolation: Initial Final Medial Total	69 44 20 32	Average Average Average Average
Deletion: Compounds & syllables Phonemes Total	39 16 20	Average Borderline low average Average
Substitution: With manipulatives Without manipulatives Total	32 49 41	Average Average Average
Blending: Syllables Phonemes Total	58 34 38	Average Average Average
Graphemes: Consonants Long & short vowels Consonant blends Consonant digraphs R-controlled vowels Vowel digraphs Diphthongs Total	31 83 15 60 45 15 48 29	Average Average Below average Average Average Below average Average Average

Decoding:		
VC words	83	Average
CVC words	64	Average
Consonant digraphs	65	Average
Consonant blends	21	Average
Vowel digraphs	<10	Below average
R-controlled vowels	44	Average
CVCe words	<10	Below average
Diphthongs	18	Average
Total	25	Average
TOTAL TEST	29	Average

- Reading of sight words and spelling of single words was assessed using the ESSI Reading and Spelling Test. Results were as follows:

ESSI SUBTEST	PERCENTILE RANK*	INTERPRETAION
Reading of sight words	60	Average
Spelling of single words	60	Average

- Rate, accuracy and comprehension of oral reading was evaluated using the Neale Analysis of Reading Ability 2nd Revised Edition (NARA) (Neale, 1997).

NARA 2 SUBTEST	PERCENTILE RANK*	INTERPRETATION
Accuracy	4	Significantly below average
Comprehension	13	Below average
Rate	<4	Significantly below average

- Speech production was evaluated using the Edinburgh Articulation Test (Anthony, Bogle, Ingram & McIsaac, 1971). All of Child B's speech sounds were age appropriate and intelligible in conversation.
2. Treated (List A) and untreated (List B) probe results at t1 (pre intervention phase), t2 (baseline period) and t3 (post intervention phase):
- Single word reading level on Comprehension TherAppy app (Tactus Therapy Solutions)

	LIST A	LIST B
T1	11%	11%
T2	63%	72%
T3	93%	85%

- Phrase word reading level on Reading TherAppy app (Tactus Therapy Solutions)

	LIST A	LIST B
T1	11%	11%
T2	68%	68%
T3	91%	75%

3. Post intervention results and comparison on standardized measures:

- ESSI Reading and Spelling Test (Esterhuyse & Beukes, 1997).

SUBTEST	Pre-intervention		Post-intervention	
	PERCENTILE RANK*	INTERPRETAION	PERCENTILE RANK*	INTERPRETAION
Reading of sight words	60	Average	60	Average
Spelling of single words	60	Average	60	Average

- Neale Analysis of Reading Ability 2nd Revised Edition (Neale, 1997).

SUBTEST	Pre-intervention		Post-intervention	
	PERCENTILE RANK*	INTERPRETATION	PERCENTILE RANK*	INTERPRETATION
Accuracy	4	Significantly below average	12	Below average
Comprehension	13	Below average	14	Below average
Rate	<4	Significantly below average	9	Below average

Appendix K: Child F's pre intervention assessment results, probe items and post intervention assessment results

1. Pre intervention standardized assessment results:

- Behaviour during assessment:
Child F was a lively, bright child who was co-operative during all of the sessions. She liked to make jokes and at times became talkative, going off on a tangent about either a related or unrelated topic. In these instances she needed to be reminded to focus on the task at hand.
- Receptive and expressive language components were evaluated using The Clinical Evaluation of Language Fundamentals Fourth Edition (CELF 4) (Semel, Wiig & Secord, 2003).

SUBTEST	PERCENTILE RANK*	INTERPRETATION
Concepts and following directions	75	Average
Word structure	25	Average
Recalling sentences	37	Average
Formulated sentences	37	Average
Word classes - receptive	75	Average
Word classes - expressive	63	Average
Sentence structure	75	Average
Expressive vocabulary	25	Average
Understanding spoken paragraphs	84	Average
Number repetition - forward	37	Average
Number repetition - backward	91	Above average
Number repetition - total	75	Average
Word associations	n/a	Normal
Rapid automatic naming (RAN) - time	n/a	Slower than normal
Rapid automatic naming (RAN) - errors	n/a	Normal

*16 – 84 = average range

Note: Child F became agitated and frustrated during the RAN task that required her to name shapes, because she was highly aware of her difficulty with this (as mentioned in her background information). This difficulty with naming shapes was likely to have contributed to her 'slower than normal' score for timing in the RAN task.

- Auditory perceptual skills were evaluated using The Test of Auditory Processing Skills Third Edition (TAPS 3) (Martin & Brownell, 2005).

SUBTEST	PERCENTILE RANK*	INTERPRETATION
Word discrimination	75	Average
Word memory	50	Average
Auditory comprehension	75	Average
Auditory reasoning	84	Average

- Phonological awareness was evaluated using the Phonological Awareness Test 2 (PAT 2) (Robertson & Salter, 2007).

SUBTEST	PERCENTILE RANK*	INTERPRETATION
Rhyming: Discrimination Production Total	2 73 11	Significantly below average Average Below average
Segmentation: Sentences Syllables Phonemes Total	75 5 90 40	Average Below average Above average Average
Isolation: Initial Final Medial Total	69 43 23 34	Average Average Average Average
Deletion: Compounds & syllables Phonemes Total	70 37 56	Average Average Average
Substitution: With manipulatives Without manipulatives Total	88 25 52	Average Average Average
Blending: Syllables Phonemes Total	12 39 27	Below average Average Average
Graphemes: Consonants Long & short vowels Consonant blends Consonant digraphs R-controlled vowels Vowel digraphs Diphthongs Total	69 28 40 62 90 18 56 50	Average Average Average Average Average Average Average Average

Decoding:		
VC words	60	Average
CVC words	54	Average
Consonant digraphs	65	Average
Consonant blends	24	Average
Vowel digraphs	26	Average
R-controlled vowels	17	Average
CVCe words	<15	Below average
Diphthongs	40	Average
Total	33	Average
TOTAL TEST	40	Average

- Reading of sight words and spelling of single words was assessed using the ESSI Reading and Spelling Test (Esterhuyse & Beukes, 1997).

SUBTEST	PERCENTILE RANK*	INTERPRETAION
Reading of sight words	60	Average
Spelling of single words	60	Average

- Rate, accuracy and comprehension of oral reading was evaluated using the Neale Analysis of Reading Ability 2nd Revised Edition (Neale, 1997).

SUBTEST	PERCENTILE RANK*	INTERPRETATION
Accuracy	18	Average
Comprehension	26	Average
Rate	13	Below average

- Speech production was evaluated using the Edinburgh Articulation Test. Child F substituted the /f/ sound for the 'th' sound in conversational speech.

2. Treated (List A) and untreated (List B) probe results at t1 (pre intervention phase), t2 (baseline period) and t3 (post intervention phase):

- Phrase reading level on the Reading TherAppy app (Tactus Therapy Solutions)

	LIST A	LIST B
T1	11%	11%
T2	60%	62%
T3	96%	71%

- Sentence reading level on the Reading TherAppy app (Tactus Theraoy Solutions)

	LIST A	LIST B
T1	7%	7%
T2	79%	79%
T3	93%	100%

3. Post intervention results and comparison on standardized measures:

- ESSI Reading and Spelling Test (Esterhuyse & Beukes, 1997).

SUBTEST	Pre-intervention		Post-intervention	
	PERCENTILE RANK*	INTERPRETAION	PERCENTILE RANK*	INTERPRETAION
Reading of sight words	60	Average	60	Average
Spelling of single words	60	Average	77	Average

- Neale Analysis of Reading Ability 2nd Revised Edition (Neale, 1997).

SUBTEST	Pre-intervention		Post-intervention	
	PERCENTILE RANK*	INTERPRETATION	PERCENTILE RANK*	INTERPRETATION
Accuracy	18	Average	24	Average
Comprehension	26	Average	22	Average
Rate	13	Below average	24	Average

Appendix L: Child E's qualitative pre intervention assessment results, probe items and post intervention assessment results

1. Pre intervention qualitative assessment results:

- Qualitative receptive and expressive language assessment (based on the Reynell Developmental Language Scales (3rd edn.) (Edwards et al., 1997):

Standardized scores could not be used as this test was administered qualitatively in order to describe Child E's oral language profile. Her strengths and weakness in language comprehension and expression are described below.

Her strengths included the following:

- Comprehension and naming of single objects
- Relating two named objects (e.g. 'Put the teddy on the bed')
- Comprehension and naming of basic verbs (e.g. sit, stand, jump) with repetition
- Comprehension of basic adjectives (e.g. blue, red, sad, little)
- Comprehension of basic prepositions (e.g. on top, under, next to, in front)
- Use of regular past tense verbs (e.g. cried, walked)

Some of her weaknesses included the following:

- Comprehension of clausal constituents (e.g. make teddy push the box, make teddy sit on the box)
- Comprehension of verbs and thematic role assignment (e.g. the girl's splashing the boy, the boy's carrying an elephant)
- Comprehension and expression of complex vocabulary and grammar
- Comprehension of inferences
- Use of some regular plural forms (e.g. balloons, buses)
- Use of inflections in verb forms (e.g. she runs, they walk)
- Use of sentences with three or more clauses
- Imitation of complex sentences

- Use of auxiliaries, questions and negative forms
- Qualitative Phonological Awareness assessment (based on the Phonological Awareness Test 2 (PAT 2) (Robertson & Salter, 2007)):

Phonological Awareness Skill	Description of task	Outcome
Rhyme identification	Two words were presented and she had to identify whether they rhymed or not.	She battled to discriminate between rhyming and non-rhyming word pairs
Rhyme production	A word was presented and she had to produce a word that rhymed with.	She was able to produce a rhyming word on 1 out of the 5 trials presented (20%).
Syllable segmentation	She was required to segment the word into syllables (clapping out each syllable as she said the word).	She was able to correctly segment words on 2 out of the 5 trails (40%). She was able to segment monosyllabic and bisyllabic words, but struggled with words of more than two syllables.
Phoneme segmentation	She was required to segment the word into its sounds/phonemes.	She was unable to segment phonemes when verbally presented with the word. She was able to segment most CVC words when given written cues.
Isolation of initial, medial and final sounds	She was required to identify the first, middle and last sounds in a word.	She could identify the initial sounds in 83% of the words but was only was able to identify the middle and last sound with verbal prompting.
Blending of syllables	Syllables of a word were presented verbally one second apart (e.g. win-dow).	She was able to blend 1 out of the 5 trails (20%).
Blending of phonemes	Phonemes of a word were presented one second apart (e.g. m-e).	She was unable to perform this task despite maximal cueing.
Grapheme-phoneme correspondence	She was presented with individual letters/graphemes and was required to produce the sound/phoneme that corresponded to them.	She is able to identify most 14 out of 20 consonants (70%) and all of the short vowels correctly. Sometimes she gave the letter name as opposed to the letter sound. Long vowels and vowel combinations were not assessed. She was able to identify the consonant digraphs 'sh' and 'wh' but unable to identify 'ch' and 'th'.
Phoneme-grapheme correspondence	She was presented with individual sound/phonemes and was required to write the letters/graphemes that corresponded to them.	She was able to write 8 of the 10 sounds presented, however some letter reversals and incorrect letter formation was present.

- Qualitative literacy assessment:

- Reading:

Reading of single words was assessed using 6 three letter consonant-vowel-consonant (CVC) words as well as sight words that Child E practiced daily with her facilitator.

For CVC words, Child E was able to segment the letters into the relevant sounds, but was unable to blend them/put them together to form a word. Her facilitator confirmed this, and reported that difficulties with blending letters was one of Child E's main problems when reading.

Sight words consisted of two to four letter words and included the following:

- Articles (e.g. a, an),
 - Prepositions (e.g. on, up, down),
 - Pronouns (e.g. I, me, it) and
 - Basic nouns (e.g. mum, dad)
 - Basic verbs (e.g. see, is, look)
 - Basic adjectives (e.g. big)
 - Functional words (e.g. no)

Of the 15 sight words tested, she was able to read seven of them accurately and independently (47 percent correct).

- Spelling:

Child E was able to write her name correctly.

She was able to correctly write 47 percent of letters tested.

She was unable to write simple CVC words e.g. 'cat'

- Speech:

Speech production was characterized by imprecise articulation as a result of structural and functional oral motor difficulties. Speech production contained sound simplifications and sound substitutions, which resulted in poorly intelligible speech. Her vocal quality was mildly horse.

2. Treated (List A) and untreated (List B) probe results at t1 (pre intervention phase), t2 (baseline period) and t3 (post intervention phase):

- Single word reading level on the Comprehension TherAppy app (Tactus Therapy Solutions)

	LIST A	LIST B
T1	15%	15%
T2	40%	40%
T3	80%	65%

3. Post intervention results and comparison on qualitative measures:

- Qualitative Phonological Awareness assessment (based on the Phonological Awareness Test 2 (PAT 2) (Robertson & Salter, 2007)):

Phonological Awareness Skill	Description of task	Pre intervention outcome	Post intervention outcome
Rhyme identification	Two words were presented and she had to identify whether they rhymed or not.	She battled to discriminate between rhyming and non-rhyming word pairs	Same as pre intervention outcomes
Rhyme production	A word was presented and she had to produce a word that rhymed with.	She was able to produce a rhyming word on 1 out of the 5 trials presented (20%).	She was able to produce a rhyming word on 2 out of the 5 trials presented (40%).
Syllable segmentation	She was required to segment the word into syllables (clapping out each syllable as she said the word).	She was able to correctly segment words on 2 out of the 5 trails (40%). She was able to segment monosyllabic and bisyllabic words, but struggled with words of more than two syllables.	She was able to correctly segment words on 3 out of the 5 trails (60%). This time she struggled to segment monosyllabic words, but was able to segment bi- and trisyllabic words
Phoneme segmentation	She was required to segment the word into its sounds/phonemes.	She was unable to segment phonemes when verbally presented with the word. She was able to segment most CVC words when given written cues.	She was able to segment the phonemes of 3 out of the 5 items (60%). She was able to do this auditorily, without written cues.
Isolation of initial, medial and final sounds	She was required to identify the first, middle and last sounds in a word.	She could identify the initial sounds in 83% of the words but was only able to identify the middle and last sound with verbal prompting.	She was able to identify the initial sounds in 33% of the words. Isolation of medial and final sounds was unchanged
Blending of syllables	Syllables of a word were presented verbally one second apart (e.g. win-dow).	She was able to blend 1 out of the 5 trails (20%).	She was able to blend 2 out of the 5 trails (40%).
Blending of phonemes	Phonemes of a word were presented one second apart (e.g. m-e).	She was unable to perform this task despite maximal cueing.	She was able to blend 25% of the trials.
Grapheme-phoneme correspondence	She was presented with individual letters/graphemes and was required to produce the sound/phoneme	She is able to identify most 14 out of 20 consonants (70%) and all of the short vowels correctly. Sometimes she gave the letter	Unchanged from pre intervention

	that corresponded to them.	name as opposed to the letter sound. Long vowels and vowel combinations were not assessed. She was able to identify the consonant digraphs 'sh' and 'wh' but unable to identify 'ch' and 'th'.	
Phoneme-grapheme correspondence	She was presented with individual sound/phonemes and was required to write the letters/graphemes that corresponded to them.	She was able to write 8 of the 10 sounds presented, however some letter reversals and incorrect letter formation was present.	Unchanged from pre intervention

Appendix M: Children interview questions

1. What did you enjoy about the activities?

Probes/prompts:

- What did you like best? Why?
- Did you enjoy working on the iPad®? Why?

2. What did you not enjoy about it?

Probes/prompts:

- Was it too difficult or too easy? What made it this way?
- Was it boring? Why?

3. What could we do to make the activities better?

Probes/prompts

- Did you like the pictures?
- Did you like to do this activity on your own?
- Did it make it easier or more fun if I did it with you?

4. Do you like to read?

Probes/Prompts:

- What do you think about the reading activities we have done together?
- Why do you think reading is important for children?
- Is it easy or difficult for you to read? Why?

Appendix N: Transcribed child participant interviews

1. Child G

Start of interview:

Researcher: What did you enjoy about the activities we did together? What did you enjoy about what we did on the iPad®?
Hmmm?

Child G: Um, I enjoy (pause) um (pause) having fun.

Researcher: Mmm

Child G: And it's always nice when you get it right and you reading it

Researcher: Ahh

Child G: And the iPad® makes you more learn and its so nice because you always want to stay there because its make you like stay there because you want to learn more.

Researcher: Oh wow...beautiful

Child G: And when you get, and when you listen well you get a prize.

Researcher: (laughs) You like that. Ok good.
What did you not enjoy about the iPad® work?

Child G: When I get it wrong.

Researcher: Ahh. So when you get one of the answers wrong? Oh okay.
And if I do this iPad® work with another child, what can I do better next time, do you think? With the lessons. What can I do to make the lessons better with the iPad®?

Child G: You make (uh) when he gets it right, when he's in grade one now he gets in grade two now you make him another lesson.

Researcher: What do you mean? Say again...So when he's in grade...

Child G: (interrupts) Like...

Researcher: Ya?

Child G: Like when he's in grade one now when he gets to grade two (indistinct) you make him you make another lesson for him.

Researcher: More lessons? So when he gets to grade two he must have more lessons? Is that what you mean?

Child G: I mean a new lesson.

Researcher: Different lessons. Oh ok. So did you not like it when we went over the same words? Was that not nice?

Child G: No, I mean that when you in grade one now you can't, when you get in grade two now, you can't start over the, the new, the new lesson you started in grade one. So you have to start the new one.

Researcher: Oh, so when you're in grade two you must have a whole new lesson? Okay.

(pause)

Okay, and then (pause), last question is: Do you like to read?

Child G: Yes, so much.

Researcher: And why?

Child G: Because sometimes when its make you learn and when you, because, our teacher had a story that, when, when she's (indistinct), out teacher when she was at school she always didn't like to read, now when she get to high school, she struggled in high school.

Researcher: Oh really? Okay. So what did you learn from that?

Child G: It's nice to read because its make you more enjoy and make you read every day.

Researcher: Oh wow, okay. (indistinct) is it easy or is it difficult for you to read?

Child G: Words that I'm learning from books we taking from school, it's easy for me, but others they not.

Researcher: Okay, so if you know the book then it's easy? Okay

Child G: Other words are difficult for me

Researcher: Mmm
(Pause)
Okay, thank you.
With the iPad®, did you like the pictures on the iPad®?

Child G: Yes

Researcher: Okay. And (pause) was it more fun if I let you do it by yourself or if I talked to you about the things?

Child G: When you helped me.

Researcher: When I helped you, okay.

Child G: And I also like when I get the answer wrong and then you help me (indistinct).

Researcher: Ahh.
(pause)
Thank you so much for all this very helpful information. Now I know what to do with the next child, so thank you.

End of interview.

2. Child S

Start of interview:

Researcher: What did you enjoy about what we did on the iPad®? What was fun about it?

Child S: Uh (pause) explaining what it means.

Researcher: Ah, explaining what it means. So when we spoke about all the things (items)?

Child S: (pause)

Researcher: explaining what the words meant?

Child S: Ya.

Researcher: Okay, and did you enjoy working on the iPad®, or would you have enjoyed working with paper and pictures more?

Child S: Um, iPad®.

Researcher: iPad®, and why? Why is the iPad® more fun?

Child S: It's cos like pencils you have to write (indistinct) but an iPad® you can just click it.

Researcher: Okay cool, thank you for that.
(pause)

Um, and the work that we did, was it, was there anything that you didn't like about it? Cos you told me now you liked the explaining part and you liked working on the iPad®, but was there something that you didn't like about what we did?

Child S: No.

Researcher: No, and was it not too difficult for you?

Child S: No.

Researcher: Or even too easy perhaps?

Child S: Ya.

Researcher: Was it even too easy? Why?

Child S: Um (pause) not the second one, the first one.

Researcher: What do you mean by the first one? The single words?

Child S: Ya.

Researcher: Okay
(pause)
And was it ever boring?

Child S: Ya.

Researcher: When and what was boring?

Child S: Um (pause) when you do a lot of words.

Researcher: (laughs)

Child S: That time when we did a lot of words – a hundred words.

Researcher: Oh, that. Ya but that was, um...

Child S: (interrupts) The test

Researcher: The test (probe items), ya

Child S: Are you going to also do this with (Child B)?

Researcher: Yes.

Child S: Or did you ready do it?

Researcher: I haven't done it yet, I'm still going to do it with her.
So, I'm not talking about the test, I'm talking about when I used to
see you for half an hour at a time, remember?

Child S: Ya?

Researcher: Was that boring, was what I want to know?

Child S: Um no

Researcher: No, okay.
Alright, now (pause) If I do this with another girl at school, what
can I do, do you think, to make it better?

Child S: Uh (pause) Uh (pause) Uh

Researcher: Take your time, you can think.

Child S: Hmm (pause). Let me think.

Researcher: So how could we make it better?

Child S: So every time when she gets it right...

Researcher: Yes?

Child S: You give her a point.

Researcher: Ahh okay.

Child S: Then, this thing called (indistinct), and then when she gets to twenty...

Researcher: Mmm...

Child S: You give her popcorn.

Researcher: Okay. So if you get a certain amount of points, then you get a prize, like, little sweets along the way.

Child S: Ya, ya.

Researcher: Aah. (pause)
And (pause)

Child S: But you can also get it on your iPhone or your computer.

Researcher: What?

Child S: That point thing.

Researcher: Oh. Do you mean if you're doing it by yourself at home?

Child S: Ya. You can, you can get it, it's called (indistinct) so you can just make your name

Researcher: Mmm

Child S: And you monster, but okay...

Researcher: (interrupts) Is this what you have in class already?

Child S: Ya, ya

Researcher: Oh okay.

Child S: And then you can make how much as you want to then you can give points and you can also minus points.

Researcher: Oh okay.
And did you like the pictures on the screen that came up on the iPad®? Were they clear? Were they easy to see?

Child S: Ya

Researcher: Ya, okay.
And, did you like the, did you like it that I did this with you or would you have liked me just to leave it with you by yourself, when you do it by yourself? Is it more fun doing it with me, or would you think maybe by yourself?

Child S: Um (pause) Maybe by myself.

Researcher: Ahh. Why?
Because you said it me it was fun when I explained all the things to you? So why would it be better to do it on your own?

Child S: Uhh (laughs)

Researcher: (Laughs)

Child S: Uh, so we don't have to stop.

Researcher: Okay. But didn't it make it easier or more fun when I did it with you, when I helped you I mean?

Child S: You mean like, help me by, like, don't, like explain it?

Researcher: No, when I explained it, when I helped you, when I did all that. Was it easier?

Child S: Um, ya.

Researcher: (indistinct) more fun that way?

Child S: Um, ya.

Researcher: Mmm
(pause)

Child S: I wonder what's in there?

Researcher: Okay, and now I'm going to ask you a question about reading, okay, a general question, not about what we did.

Child S: Ya.

Researcher: Do you like to read?

Child S: Ya

Researcher: You do? Okay(pause)
And um, why do you think reading is important for children? You say you like to read, but why do you think it's important for children?

Child S: Hmm, so you can see the words.

Researcher: Ya.
(pause)
And do you find easy reading, I mean easy, uh, reading difficult or easy? Whats it like for you?

Child S: Middle, middle.

Researcher: Middle, middle. And why?

Child S: Sometimes it's easy and sometimes it's hard.

Researcher: Okay.
(pause)
Okay, thank you (Child S).

End of interview.

3. Child B

Start of interview:

Researcher: Okay (Child B), what did you enjoy about the stuff we did together?

Child B: The iPad®.

Researcher: You liked the iPad®?

Child B: Yes.

Researcher: Okay, and why? Why did you like working on the iPad®?

Child B: Because it had a lot of reading.

Researcher: Ah. Cool, okay.
And was there anything you did not enjoy?

Child B: No.

Researcher: No?

Child B: (laughs)

Researcher: (laughs) Was it too difficult, or too easy maybe? Or was it okay?

Child B: It was okay.

Researcher: Okay, and, what could we do to make working on the iPad® better for the next child I see? Next time, what could I do to make it better, do you think?

Child B: Hmm, I don't know.

Researcher: You don't know. Okay (pause).
Did you like the pictures on the iPad®? The pictures they used?
Was that nice or not?

Child B: Yes.

Researcher: Okay (pause) and it you like it when I left you alone to do it by yourself, or did you like it when we spoke about the things together?

Child B: Spoke about the things.

Researcher: Okay. Was that more, was that more fun when we spoke about it, what we saw?

Child B: Ya.

Researcher: Okay (pause)
And then, I have another question for you. This is our last question, and it is: Do you like to read.

Child B: Yes.

Researcher: Although I already think I know the answer to that (laughs). Yes, okay.

Child B: Yes.

Researcher: And why do you think reading is important for children?

Child B: Um, because um, you can go like to the, the um, actually don't know.

Researcher: And is it easy or is it difficult for you to read?

Child B: Easy.

Researcher: It's easy? Why's it easy for you?

Child B: Because, every time I get a chapter book in the library, and I also get a chapter book in class...

Researcher: (interrupts) wow, so you're even reading chapter books?

Child B: Ya.

Researcher: Are those harder, than the normal ones?

Child B: A little bit hard.

Researcher: Wow, so that's why you know its easy for you. Thank you (Child B).

End of interview.

4. Child F

Start of interview:

Researcher: So my first question to you is, what did you enjoy about the activities we did together?

Child F: Mmm (pause) I, I enjoyed the mmm, (pause), the (pause) the iPad stuff.

Researcher: Oh you enjoyed the iPad stuff.

Child F: Cos I love reading.

Researcher: Ahh
(pause)
And what did you not enjoy about what we did together?

Child F: Getting it all wrong (laughs)

Researcher: (laughs) But you got everything right! (laughs)
Did you not like it when you got something wrong?

Child F: Yes because (laughs), because its just, never mind.

Researcher: You can say.

Child F: But it's hard to explain.

Researcher: Okay, do you want to try?

Child F: Mmm, I don't know how to explain it.

Researcher: Okay.

Child F: It's just like that.

Researcher: Okay. Was it too difficult or too easy?

Child F: Mmm (pause) both. Middle!

Researcher: Middle

Child F: (indistinct)

Researcher: And was it boring at all?

Child F: N...O.

Researcher: No, okay.

Child F: (indistinct)
(laughs)

Researcher: Okay my other question to you is: What could we do to make this, the activities, better?

Child F: A bit more harder.

Researcher: Ahh.

Child F: 'Cos it's fun for me to make it more harder. Sort of. (pause) But then I can try harder. See?

Researcher: Yeah.

Child F: There're two (name) in here, one from this class, one from the other class.

Researcher: Okay. And did you like the pictures?

Child F: Mmm, yes.

Researcher: And (pause)

Child F: And I liked the lobster one (laughs)

Researcher: Ahh.

Child F: And the plane one. The one where he's sleeping in the bed, but the plane one was so funny. You know I was talking about it?

Researcher: Ye, when we spoke about the plane.

Child F: And then, rush hour.

Researcher: (laughs) sugar rush hour.

Child F: No, rush hour.

Researcher: Ya, you called it sugar rush hour.

Child F: Yes.

Researcher: Okay and then my last question is: Do you like to read?

Child F: I said yes last time (laughs)

Researcher: Yeah, that's true, you did.

(pause)

And why do you think reading is important for children?

Child F: Because then you learn new words and know how to read it when like somebody goes in front of you and you have a (indistinct) and then you know what the words mean

Researcher: Ahh

Child F: And like if the let, if somebody gives you a letter and that.

Researcher: Oh okay.

And is it easy or is it difficult for you to read?

Child F: Both, middle.

Researcher: Middle. And why? Why do you say in the middle?

Child F: Because some words I have to sound out and I have to figure out which sound. Sometimes, /o/, sometimes it has to be a /o/ and a /u/ and it might not, and sometimes the /u/ or the /o/ might not, the 'apposed to be not making any noises.

Researcher: Oh like silent letters and that?

Child F: Ya.

Researcher: Oh okay. Alright, thank you (Child F).

End of interview.

5. Child E

Start of interview:

Researcher: Okay. Alright (Child E). My first question to you is: What did you enjoy about the activities we did together?

Child E: (pause)

Researcher: What did you enjoy about what we did on the iPad?

Child E: (makes noises)

Researcher: (Child E), look at me. What did you enjoy about working together with me?

Child E: (pause)

Researcher: What did you like best?

Child E: (pause)

Researcher: Did you enjoy working on the iPad?

Child E: (nods)

Researcher: Okay, and why? (pause) Why did you like the iPad? Why was it fun?

Child E: To click on words

Researcher: To click on words, okay.
(pause)
And, what did you not like about what we did together?

Child E: Help

Researcher: Hey?

Child E: (indistinct) like help.

Researcher: You like the help?

Child E: No

Researcher: You don't like being helped?

Child E: (nods)

Researcher: Okay
(pause)
Was it too difficult, or was it too easy what we did?

Child E: Easy.

Researcher: Easy? Why was it easy?

Child E: I can click the pictures.

Researcher: Oh

Child E: Why you writing down?

Researcher: So I don't forget anything.
(pause)
And, was it boring?

Child E: No.

Researcher: No, okay.
Alright, and what can we do, um, what can we do to make the, the
games better, or activities better?

Child E: (indistinct) picture.

Researcher: Hey? (pause) Can you say again? What can we do to make the
activities better? (pause) For other children who do it.

Child E: (no response)

Researcher: Did you like the pictures?

Child E: (nods)

Researcher: And did you like to do this activity by yourself?

Child E: (nods)

Researcher: Did it make it easier for you if I helped you?

Child E: Yes.

Researcher: And was it more fun if I helped you?

Child E: Yes.

Researcher: Okay.
(pause)

Okay, last question: Do you like to read?

Child E: Yes.

Researcher: And why do you like to read?

Child E: I remember the words.

Researcher: Ahh
(pause)
And, um, why do you think reading is important?

Child E: To look at, look at the book.

Researcher: Okay.
(pause)
And is it easy or difficult for you to read, (Child E)?

Child E: Easy.

Researcher: Easy, why's it easy?

Child E: I can (indistinct), I can wrote the words, (pause) and (indistinct) the pictures.

Researcher: So do pictures make it easier for you to read?

Child E: Yes.

Researcher: Okay. Thank you so much.

End of interview

Appendix O: Examples of untreated probe items for outcomes measures based on a linguistic hierarchy and psycholinguistic principles as outlined by Pascoe et al. (2006) and Roth and Worthington (2010)

- Intervention Level A – single words

e.g. Moon
 Cake
 Star

- Intervention level B – phrases

e.g. bag of apples
 a broken arm
 the happy baby

- Intervention level C – sentences

e.g. The icing on the cake is red
 She turns on the lamp
 They swim in the round pool